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ANGLO-AMERICAN CO-OPERATION IN COLONIAL DEVELOPMENT

THE developments in the campaign against the tsetse fly in Central Africa, and the recently published report of the Commission of Enquiry into the Swollen Shoot Disease of Cacao in the Gold Coast (see *Nature*, January 15 and 22, and February 19), have emphasized the importance of the contribution which science has to make to the health and development of the backward territories, and through them to human welfare generally. Furthermore, the very nature of the latter Commission, consisting as it did of scientific men selected from a list prepared by the United Nations Food and Agriculture Organisation, demonstrates the value of international co-operation in this field ; and especially of regional developments, such as the conferences with the French, Belgian and Portuguese Governments, and the discussions with the French Government and other associated Governments on the possibility of co-operation in development schemes to which the Colonial Secretary, Mr. Creech Jones, referred in a House of Commons debate on Colonial affairs last July. Mr. Creech Jones clearly recognized that in such areas as West and Central Africa, co-operation between these Powers in tackling the fundamental problems of Colonial development is all-important.

The fourth proposal made by President Truman in his inaugural speech on January 20, namely, that the United States should embark on a bold new programme for making the benefits of her scientific advances and industrial progress available for the improvement and growth of under-developed areas, will therefore be widely welcomed. Mr. Truman said :

"More than half the peoples of the world are living in conditions approaching misery. Their food is inadequate. They are victims of disease. Their economic life is primitive and stagnant. Their poverty is a handicap and a threat both to them and to more prosperous areas. For the first time in history humanity possesses the knowledge and skill to relieve the suffering of these peoples.

"The United States is pre-eminent among nations in the development of industrial and scientific techniques. The material resources which we can afford to use for the assistance of other peoples are limited. But our imponderable resources in technical knowledge are constantly growing and are inexhaustible. I believe that we should make available to peace-loving peoples the benefits of our store of technical knowledge . . . and in co-operation with other nations, we should foster capital investment in areas needing development. Our aim should be to help the free peoples of the world, through their own efforts, to produce more food, more clothing, more materials for housing and more mechanical power to lighten their burdens. We invite other countries to pool their technological resources in this undertaking. Greater production is the key to prosperity and peace. And the key to greater production is a wider, more vigorous application of modern scientific and technical knowledge."

This invitation to a co-operative enterprise in which all nations work together through the United Nations and its specialized agencies, wherever practicable, could scarcely have been issued unless there lay behind it the draft of a project in which ways and means are dealt with in considerable detail. It is true that President Truman linked this proposal with the continuance of support of the United Nations and of the European Recovery Programme as well as with the support of freedom-loving nations against aggression by regional pacts, such as those embodied in the treaty of Rio de Janeiro or at present being worked out for the North Atlantic Area. Nevertheless, it is not easy, even with the precedent of the Colonial Development Corporation before us, to visualize the exact means by which this idea of co-operative capital development can be made to work.

Capital investment is admittedly one of the fundamental needs of the backward areas; but even if the proposal means that the United States are prepared to take over the role of leadership in this century which Britain filled in the last, the task is immensely more complicated. Against the greater advantages and resources for human welfare which science and technology have given us to command, there have to be set the growth of nationalism and the extent to which the expectations of the under-privileged everywhere have been magnifying the standards achieved in more prosperous countries. Even without the existence in Communism of a political force which not only makes these aspirations articulate but also may confuse the issues to support a rival bid for world leadership, the task of reconciling opposing, or apparently opposed, interests will be far from easy. The report of the Commission of Enquiry into the Swollen Shoot Disease of Cacao in the Gold Coast provides sufficient illustration of the way such considerations may intrude on a purely scientific or technical problem.

Mr. Truman's statement was warmly welcomed by the Foreign Secretary, Mr. Bevin, in his speech to the Foreign Press Association on January 25. Mr. Bevin thought that all the Powers responsible for overseas territories would throw into the pool all the knowledge, ability and resources they had at their command. Successive Colonial Secretaries have already made plain the readiness of Britain to associate herself with schemes of regional development in the Caribbean, Africa and elsewhere, while at the same time dissociating themselves from any idea of international government. Discussions, in fact, have already taken place in Paris on the possibility of closer economic co-operation between France and Great Britain in their Colonial territories.

Unfortunately, the Trusteeship Council of the United Nations has so far conspicuously failed to win the respect accorded by the Colonial as well as the Mandatory Powers to the Permanent Mandates Commission of the League of Nations. Time will be required to dispel the suspicion that the new Council is being used mainly as a sounding board for irresponsible and destructive criticism and not as an organ of co-operation. Meanwhile, quite apart from the fact that the whole trend of President Truman's statement indicates that he is prepared to use other agencies where the specialized agencies of the United Nations are ineffective, there has already been demonstrated a growing measure of international co-operation in the scientific and technical field, and it is on this field that President Truman laid particular stress. No such obstacles as may beset the proposition for co-operative capital development, with the necessity for dovetailing such projects very carefully with the demands made under the Marshall Plan, need hinder the spread of technical knowledge in these undeveloped areas.

That in itself is a long-term project which will require time for fruition. There are, however, various ways in which the United States could probably render immediate and direct assistance. Thus it could share its own pre-eminent development of industrial and scientific techniques at no great cost by broadening the facilities offered to students of all nations to study in the universities and technical institutes of the United States. This would do much more than simply ease the great strain placed on the over-crowded universities of Great Britain through the admission of increased numbers of overseas students and co-operation in the development of the new universities throughout the Colonial Empire. The students may be expected to carry back to their own lands both knowledge and also an enduring appreciation of the American way of life.

Whether such help is given in the form of men and women, or of space in educational institutions, or of finance—and in few fields could a relatively small financial outlay bring such a large return—it can only be welcomed by Britain and other Colonial Powers. At first, indeed, it can only be on a small scale, for students well equipped to profit by the opportunity will not easily be found until education has further advanced in the African and other backward territories concerned. Some part of the American effort might accordingly take the alternative form of assisting educational enterprises in lands that have not the resources to break the fetters of illiteracy for themselves.

Significantly enough in this connexion, it may be recalled that the Colonial Office has already asked the United States Economic Co-operation Administration whether American men of science and technicians could fill posts in the Colonial Geological Survey and the Colonial Geodetic and Topographical Survey until the recruiting position caused by the gap in training during the war years improves. The vacancies are for reconnaissance work required before new areas can be opened up for mineral and other development, and the recruitment of some fifty Americans in this way would be a notable step in the pooling of experience. It would be a manifestation of Anglo-American partnership in service which might well contribute to the spread of Anglo-American ideas and principles in a way comparable to the permeation of Indian thought in the last century by the ideas of British educationists.

President Truman's proposal should give a further stimulus to the zeal and enthusiasm lying behind

some of the striking achievements of science and technology, which are opening up new opportunities for human welfare and economic development in Africa, and to the international and regional co-operation required to realize those possibilities. It should be remembered that, more than a year ago, in a speech in the House of Commons on January 22, 1948, the Foreign Secretary linked the development of the backward areas with the economic recovery of Western Europe. The imaginative passage in which Mr. Bevin urged the closest possible collaboration between the British Commonwealth and French, Dutch, Belgian and Portuguese as well as British overseas territories, should be set beside Mr. Truman's recent proposal.

Neither Mr. Truman nor Mr. Bevin pursued the idea into any detail. Mr. Bevin was content to emphasize that there is no inherent conflict between the social and economic development of these overseas territories to the advantage of their peoples and their development as a source of supplies for Western Europe and a contributor to the balance of payments. President Truman has clearly responded to this vision of the tremendous resources of the Middle East, Africa and the Far East being brought together, with European and American resources, for the purpose of making the whole world richer and safer. The significance of his proposal lies less in its novelty than in the evidence of American response to a challenge for economic and social planning on a bolder and more imaginative scale than the world has yet seen.

ISOTOPES IN BIOLOGY AND MEDICINE

A Symposium on the Use of Isotopes in Biology and Medicine

Contributors: Hans T. Clarke, Harold C. Urey, Glenn T. Seaborg, Paul C. Aebersold, Alfred O. Nier, Charles D. Coryell, Martin D. Kamen, Donald B. Melville, David B. Sprinson, Harland G. Wood, Konrad Bloch, David M. Greenberg, I. L. Chaikoff, Joseph G. Hamilton, Byron E. Hall, Saul Hertz, William F. Bale, James J. Nickson, Farrington Daniels. Pp. xiv+445. (Madison, Wis.: University of Wisconsin Press, 1948.) 5 dollars.

Advances in Biological and Medical Physics

Edited by John H. Lawrence and Joseph G. Hamilton. Vol. 1. Pp. xi+484. (New York: Academic Press, Inc.; London: H. K. Lewis and Co., Ltd., 1948.) 8.60 dollars.

Radioactive Indicators

Their Application in Biochemistry, Animal Physiology, and Pathology. By George Hevesy. Pp. xvi+556. (New York and London: Interscience Publishers, Inc., 1948.) 60*s*.

THESE three comprehensive volumes dealing with biological and medical applications of isotopes appear within a few months of each other, and mark a milestone in the subject. The rate of development in this field has been so rapid that the opportunity has scarcely arisen to take stock of progress. With their appearance a panoramic view of the literature is provided, with the help of which it becomes possible to assess what has been achieved and to speculate on future developments.

In the first place one is struck by some unusual, if not unique, facts about this new subject. There is, for example, the remarkable feature that it owes its development almost entirely to one man in Europe and to a large number of able investigators in America. This is reflected in the authorship of these books, which comprises G. Hevesy and thirty-one North American contributors. In the case of the radioactive isotopes, this feature may also be looked upon as a reflexion of the distribution of usable cyclotrons during the war years. Whatever truth there may be in this, it must be a cause of general satisfaction that the initial period of unequal opportunity is practically at an end and that isotopes are now within the reach of almost everyone.

It is also doubtful whether any other subject of present or past popularity can lay claim to such a wide audience. Listed among the contributors to these volumes are physicists, chemists, biochemists, physiologists, physicians and radiotherapists, each of considerable eminence in his own subject. In the case of the symposium held at Wisconsin, many of these were brought together in harmony around the same conference table, which is no ordinary occurrence in this specialized age.

Surveying some of the achievements, there is in the medical field the rapid estimation of thyroid efficiency, the location of extra-glandular thyroid tissue and the therapeutic destruction of malignant tissue whether in the gland or in functional secondaries, all by the use of radioactive iodine. This field is conservatively reviewed by I. L. Chaikoff, A. Taurog, S. Hertz and C. P. Leblond. Hevesy and P. F. Hahn set out the satisfying story of the conservation of iron in the body, particularly in relation to the life-span of the erythrocyte. The metabolism of compounds of nitrogen and carbon is reviewed by B. Vennesland and of proteins by D. B. Sprinson. Without detracting from the outstanding merit of their articles, the omission of D. Rittenberg's name from the list of contributors will not pass unnoticed. Much of his earlier work in association with R. Schoenheimer is dealt with in an article of excellent historical perspective by Hans Clarke. H. G. Wood writes on carbohydrate metabolism, whether studied indirectly with radiophosphorus or directly with carbon and deuterium. He makes no claim to completeness, and in this he has clearly been wise, since the prevailing enthusiasm for this field of work is such that in the interval since the article was written there has appeared little short of an avalanche of papers.

We owe to Hevesy more than to anyone the important conception of turnover-time, which shows signs of furnishing the basis for an entirely new point of view in biochemistry. His method of determining it, to take the case of phosphorus compounds as an illustration, is to maintain constant the specific isotopic activity of plasma phosphate and to compare it with the specific activity of the tissue compound at the end of an interval which is short in relation to the time required for complete renewal. This is the experimental basis of his statement (p. 279) that 20 per cent of the lecithin in rat liver is renewed every four hours. He fully recognizes that the value will be affected if the specific activity of intracellular inorganic phosphorus is not the same as that of plasma inorganic phosphate; in other words, the permeability of the cell membrane affects turnover time as determined by his method. However, it was

D. B. Zilversmit *et al.*[1] who first stated clearly in 1943 that the method could be seriously at fault if certain circumstances prevailed. For example, this will be the case if lecithin phosphorus happens to be derived by a rapid exchange from liver glycerophosphoric acid, which in turn happens to be synthesized only slowly from plasma phosphate. In such a case, over a short period of observation the isotope may scarcely reach the lecithin, whereas a considerable exchange of phosphate between lecithin and glycerophosphoric acid will have taken place. As Chaikoff and Zilversmit emphasize in their salutary article, it is essential to identify the immediate precursor, and Hevesy (p. 250) unequivocally supports their contention.

It will be helpful to many to find that this measure of agreement now exists between the experts. On the other hand, it was fortunate for the development of the subject that Hevesy should have adopted the less stringent conception of turnover time in his early work, since it is clearly better to have approximate figures to correct than none at all. This is certainly the choice, since the data required in order to apply the more precise method of the American workers are unobtainable for most intracellular substances or radicals. Fortunately this is not so in the case of plasma compounds, since the method of choice here, namely, to inject the labelled substance and observe its rate of disappearance from the plasma, makes no assumptions about the nature of the immediate precursor.

D. M. Greenberg writes on mineral elements, especially those of the skeleton and those possessing catalytic function, for example, iron, cobalt, manganese and zinc. Medical and therapeutic applications are left to E. C. Dougherty, J. H. Lawrence, J. G. Hamilton and B. E. Hall. There is a useful article by D. B. Melville on the preparation of compounds labelled with deuterium, carbon, nitrogen and sulphur.

A significant sign of the times is the inclusion of articles on health protection by H. M. Parker, W. F. Bale and J. J. Nickson. These are particularly timely in view of the increasing popularity of long-lived isotopes, particularly carbon-14 and iron-55, and of penetrating gamma-emitters, such as cobalt and zinc. Considerable space is devoted to the preparation and assay of isotopes, and the remaining names on the title-pages are mainly of contributors to these aspects. Much of the subject-matter here has appeared in review articles in physical and chemical journals, but its inclusion in volumes intended for the biologist is none the less welcome.

The popularity which isotopes have achieved in little more than a decade has been remarkable. It is safe to say that the next decade will see fresh discoveries in the field, but also, one hopes, the appearance of a more critical attitude to claims already made and recorded in these volumes. Following the spectacular demonstration of iodine uptake by the thyroid gland, the belief has grown that, provided an isotope emits gamma-radiation which is penetrating enough, it is only necessary to place a Geiger counter over the appropriate region of the body to derive the whole story of the isotopic uptake and excretion of a particular organ. The fallacy here is not based solely on the poor directional qualities of gamma-radiation but also on the fact that there are few sites in the body which compare with the thyroid in ability to concentrate elements selectively. Almost everywhere else, and with almost all other isotopes, there exists alike in the organ and in the surrounding tissues such a conglomeration of isotopic compounds, with vastly different exchange-rates, that the uptake and excretion by a region or organ as a whole have no useful significance.

Even where this is fully appreciated and the investigation is limited to an isolated compound, the biochemical difficulties of the isolation are, in many cases, only beginning to be appreciated. Tissue cells abound in macromolecules of high adsorptive capacity, with which are associated smaller diffusible molecules, frequently of high isotopic content. A few specialists in the field of surface chemistry have fully appreciated the tenacity of this adsorption, but many working with isotopes are apparently only now discovering it. In a recent investigation of the yeast cell[2] nearly all the phosphorus compounds isolated were found to be contaminated to some extent with other phosphorus compounds, especially metaphosphate, leading the authors to the conclusion that the results obtained from tracer experiments in general should be treated with great reserve until the fractions obtained have been reproduced by alternative methods of fractionation. Many, including the writer, will agree with this.

It is a pleasure to recommend all three volumes to serious workers in this field. For others, where a choice must be made, it is not possible to be categorical. Hevesy, in his monumental volume, has all the advantages of unity of authorship and maturity of outlook, but unavoidably he is not so reliable in some fields as the specialist contributor to the other volumes. Stable isotopes are excluded from his book, and some aspects of radioactive ones are not covered at all. Lawrence and Hamilton, on the other hand, have obtained the collaboration of specialists, including Hevesy, who are representative of the isotope field as a whole. Their articles dovetail much better than those in the symposium volume, which also shows some signs of hasty preparation.

A. S. McFarlane

[1] Zilversmit, D. B., Entenman, C., and Fishler, M. C., *J. gen. Physiol.*, **26**, 325 (1943).

[2] Juni, E., Kamen, M. D., Reiner, J. M., and Spiegelman, S., *Arch. Biochem.*, **18**, 387 (1948).

HIGH-POLYMER PHYSICS

Mechanical Behavior of High Polymers

By Assist. Prof. Turner Alfrey, Jr. (High Polymers, Vol. 6.) Pp. xiv+581. (New York and London: Interscience Publishers, Inc., 1948.) 9.50 dollars.

THE unusually wide range of subjects covered by this work, the sixth volume in this series of monographs on high polymers, makes it difficult to give an adequate idea of its contents and method of approach in a short review. The book begins with what might be called an introduction to rheology—a concise treatment of the classical theory of elasticity, flow in Newtonian and non-Newtonian liquids, plasticity and thixotropy, and the simpler types of visco-elastic behaviour. This is followed by a discussion of the molecular mechanism of flow in amorphous linear polymers, and its formal analysis in terms of model systems, leading up to the development of the concept of a distribution of 'retardation times' or 'visco-elastic spectrum', from which the behaviour of a body under any type of stress variation may be derived. The third chapter deals with the statistical theory of the elasticity of cross-linked

polymers (rubbers), and the statistical approach to the study of cross-linking and copolymerization—a fascinating field in which the correspondence between theory and experiment is refreshingly close—and associated problems.

In the remaining chapters the emphasis is on the observed properties of materials. Subjects dealt with are crystallization and its effect on mechanical properties of rubbers and fibres, the mechanical behaviour of wool and rayon, solution properties and plasticization of polymers. The final chapter deals with the question of tensile strength, both from the theoretical and experimental points of view.

Regarding the book as a whole, the treatment generally is sufficiently detailed and extensive for the reader to obtain a very fair grasp of the more important contributions to the subject, even without consulting the original literature. In many places sections of the original papers are quoted *in extenso*, which is extremely helpful for the reader who is actively engaged on research in a particular subject. On the other hand, this method has the drawback of breaking up the smooth development of the subject, making the presentation appear somewhat disjointed, with different parts of the same subject cropping up in various places. It is unfortunate that the section on optical properties could not have included a reference to the work of Kuhn and Grün (1942) on the statistical theory of the photo-elasticity of strained rubber.

The author is at his best in dealing with the general mathematical theory of visco-elastic phenomena, a subject to which he has made important contributions, some of which are set out in mathematical appendixes. The reviewer knows of no other book in which this subject is discussed in anything like the same detail, nor in such a masterly and lucid manner. Mathematics, however, is not physics, and the number of examples in which this kind of formal analysis has been successfully applied to real materials is still quite small. Moreover, there is the very serious difficulty (explicitly stated on p. 218) that the theory discussed is not applicable when the deformations encountered are large. Just as, in rubber elasticity, it has been found necessary to get right away from the classical (small-strain) theory and develop a theory in which large strains are included right at the start, so it may be necessary ultimately to develop a genuinely large-strain visco-elastic theory for the analysis of the non-equilibrium phenomena encountered in rubbers and plastics.

This is not a book for beginners; but for those who already have some knowledge and experience in high-polymer physics, it will be highly valued not only as an everyday guide but also, and perhaps primarily, as a source of inspiration for further research.

L. R. G. TRELOAR

MECHANISM OF MAGNETIZATION

Paramagnetic Relaxation

By Prof. C. J. Gorter. Pp. vii+127. (New York and Amsterdam: Elsevier Publishing Co.; London: Cleaver-Hume Press, Ltd., 1947.) 12*s*. net.

ALTHOUGH Langevin's theory of paramagnetism is known to every physics student, the study of the mechanism of the magnetization process is comparatively new; Waller's first calculations were published in 1932, and experimental investigations may be said to begin with Prof. C. J. Gorter's first paper in 1936. Since then it has been intensively studied under his leadership in several of the Dutch universities: but, up to the present, many of the results have been published only in the form of theses. This monograph, written in Holland during the 'starvation winter' of 1944–45, is the first book to be devoted to the subject.

The magnetization of a paramagnetic salt is an equilibrium between the forces exerted on the magnetic ions by the magnetic field, the random forces of thermal agitation, and the constraints due to interactions either among the magnetic ions themselves or between the ions and the surrounding crystal lattice. When this equilibrium is disturbed by a change of magnetic field, it can be re-established only by a flow of heat, which proceeds at a rate which can be described in terms of two characteristic relaxation-times. As the time for the establishment of thermal equilibrium among the magnetic ions, or spin relaxation-time, is generally appreciably shorter than that for equilibrium between the ions and the crystal lattice, and also has a different dependence on magnetic field, it is possible to separate the two effects experimentally.

After a brief review of the theory of paramagnetism, Prof. Gorter surveys the experimental methods used in relaxation work. Essentially, these are measurements of magnetic dispersion or absorption at different frequencies; but, as the relaxation times range from spin relaxation-times of 10^{-10} sec. to lattice relaxation-times which at low temperatures may exceed 0·1 sec., a great variety of techniques has been employed. The high-frequency circuit work is nowhere very elaborate—it must be remembered that the whole of the work described is based on 'pre-radar' radio technique—but some of the methods used are beautifully simple, notably the work of H. Volger. There follows a summary of the experimental results, and a discussion of their significance in the light of the theory of lattice and spin relaxation.

For many readers the greatest interest will lie in the values which emerge for the magnetic specific heats. When the spin relaxation-time is sufficiently short compared with the lattice relaxation-time, measurements at a suitable frequency give the magnetic susceptibility under adiabatic conditions, in which the magnetic dipoles, although in thermal equilibrium among themselves, are effectively isolated from the surrounding crystal lattice. From this measurement, combined with that of the ordinary isothermal susceptibility, the specific heat of the dipole system can be obtained by a simple thermodynamic transformation. In the few cases in which the comparison is possible, this elegant method gives specific heats which yield values for the magnetic energy-levels in good agreement with those obtained by other methods. The experimental results on relaxation-times, on the other hand, have not yet been fitted into a satisfactory theoretical framework. The dependence of the lattice relaxation-times on magnetic field is not consistent from one substance to another, while the experimental data do not yet suffice for a full analysis of its temperature dependence.

While its appeal is necessarily specialized, Prof. Gorter's book is an important contribution to the study of paramagnetism. It is beautifully produced and printed—an important point in a monograph containing so many numerical data. It has no index.

A. H. COOKE

Practical Five-Figure Mathematical Tables

By C. Attwood. Pp. v+74. (London: Macmillan and Co., Ltd., 1948.) 3*s*.

ALTHOUGH the contents of this volume do not differ essentially from those normally to be found in books of this kind, many innovations have been introduced in the arrangement and presentation, and the author has spared no pains to ensure that the comparatively limited space available is utilized to maximum advantage and efficiency. In addition to the ordinary tables of common logarithms, there is a supplementary table covering the range 1·000–2·099 at intervals of 0·01, and a similar feature appears in the trigonometrical sections, where entries are provided at 1′-intervals for cotangents and cosecants up to 18° and for secants and tangents in the range 72–90°.

Great emphasis has been laid, both in the preface and in a final explanatory section, on the use of proportional parts. The author explains, by means of well-chosen examples, the various methods that are available for avoiding or reducing the inaccuracies produced by mean proportional parts. The use of smaller ranges, where necessary, has already been mentioned and occurs constantly throughout the book. Other methods include backward interpolation, the use of inverse tables, and Bessel interpolation with second-order differences. Several illustrations compare and contrast the results of their application.

Other tables supplied include squares, cubes, square and cube roots, reciprocals, exponentials and hyperbolic logarithms; and the author has been wise enough to ensure that all differences to be subtracted are printed in red. He claims that more than 95 per cent of the 160,533 possible combinations of mean proportional parts produce no error or an error of one unit in the last figure, while less than 0·6 per cent produce an error in excess of three units. In a few cases, where the error is liable to exceed five units, italic type has been employed as a warning.

The book is beautifully printed and should prove a valuable asset in all elementary numerical work.

J. H. PEARCE

Technical Literature

Its Preparation and Presentation. By G. E. Williams. Pp. 117. (London: George Allen and Unwin, Ltd., 1948.) 7*s*. 6*d*. net.

MR. G. E. WILLIAMS' book is an expansion of his paper "The Presentation of Technical Literature", published in the *Journal of the Institution of Electrical Engineers* in 1944. To the extended sections of that paper Mr. Williams has now added chapters on the preparation of manuscripts, the art of sub-editing and on illustrations, and he also appends some notes on editing standards. In these respects his book differs from that of Prof. Kapp on "The Presentation of Technical Information", and although similar in scale and alike in their emphasis on the technical ideal that the treatment of a theme and the choice of words should be determined by their fitness for the purpose to be served, there are marked differences between these two books. Mr. Williams is concerned only with the writer, whereas Prof. Kapp deals with the lecturer also.

While the psychological approach is not overlooked, Mr. Williams emphasizes the factor of interest in his introduction—psychological principles bearing on the communication of knowledge are discussed separately in an appendix. Here Mr. Williams seems to be less successful than Prof. Kapp, though it is only fair to point out that these few pages are intended to serve no more than as an introduction to the subject, and that, unlike Prof. Kapp, Mr. Williams gives his readers clear guidance as to where further help may be sought. He includes a bibliography which, if not extensive, is adequate and discerning. The book is severely practical. It is lucid, well written and much to the point. For all the merits of Prof. Kapp's book, that of Mr. Williams will be preferred by many—and those not only the engineers and physicists primarily addressed—because, although slightly shorter, it is comprehensive and guides the student to the further sources where he may study, in greater detail, particular questions that arise in writing technical literature.

R. BRIGHTMAN

Notions fondamentales sur les vernis et peintures

Par Louis Kientz. Pp. xxi+234. (Paris: Gauthier-Villars, 1947.) 475 francs.

THE purpose of this book is "to inform the technician on the nature and properties of paints and varnishes". Such a limited aim the work fairly well achieves. Thus, there are chapters on resins, oils, pigments, paint testing and the like, where the information, if not novel in tenor or presentation, is of the kind likely to be useful to the paint technologist. However, some unfortunate statements have found their way into the text. Thus, to condemn fillers as solely useful for cheapening a paint, and as finding no place in a first-quality product (p. 70), is unnecessarily exclusive. It is a great pity that nothing better to illustrate the text could be found, assuming that illustrations are necessary, than a handful of ill-executed and uninformative line-drawings. The title is most misleading. It is true that a section will be found devoted to the theoretical concepts of physical chemistry, and throughout the text are scattered discussions on such matters as the mechanism of oil oxidation, structural formulæ of complex molecules, etc.; but these disquisitions are marred by a diffuseness and a lack of precision that render them more confusing than enlightening. Reference may be made, in illustration, to the inadequate treatment of viscosity and "rigidity" [*sic*] (p. 16), by which is meant anomalous viscosity, and of the classification of drying, semi- and non-drying oils (p. 45). Such imprecision, it must be admitted, is inescapable in a work almost purely descriptive; even the section on paint-testing is almost wholly uncritical. The absence of an index must seriously limit the value of this book as a work of reference.

Brachiopoda and Mollusca from the Productus Limestone of the Salt Range

By Dr. F. R. Cowper Reed. (Memoirs of the Geological Survey of India. Palæontologia Indica, New Series, Vol. 23, Memoir No. 2.) Pp. xii+596+66 plates. (Calcutta: Geological Survey of India, 1944. distributed 1948.) Rs. 63.2 or 96*s*.

ONLY a palæontologist who has lived through much of the development of his science could produce a volume such as this. The brachiopod and molluscan fauna of the Productus Limestone is described in detail with a wealth of references. Though only two new genera, *Blandfordina* (Limidæ) and *Palæolecanites* (Lecanitidæ), and one new subgenus, *Haydenella* (*Productus*), are found necessary, there are no fewer than 177 new species and 114 new varieties. In this revision of the fauna certain of the conclusions reached by Waagen in an earlier monograph are rejected. In particular, the supposed

Visean affinities of a number of species from the Lower Productus Limestone, and the proposed palæontological zoning of the Middle and Upper Productus Limestone, are shown to be unsupported by evidence. The present author considers the Productus Limestone to be wholly Permian in age.

This work enables closer correlation to be made with Permian beds in other regions, and extremely close relations are apparent with faunas from West Australia, China and Tunisia. There are many anomalies, however. The rich faunas from Indo-China and Timor, for example, contain few identical species, and many of the gastropods are "extraordinarily like" those of the Pennsylvanian of America. Arctic species occur in all three divisions of the Productus Limestone. The author would prefer to regard many of the differences of fauna between Asiatic regions as indicating ecological (facies) variation rather than actual difference in age.

ALAN WOOD

Fishes and Shells of the Pacific World

By John T. Nichols and Paul Bartsch. (Pacific World Series.) Pp. v+201+16 plates. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1946.) 12*s*. 6*d*. net.

THIS book provides an authoritative introduction to Pacific fishes and molluscs, and was written primarily to assist the thousands of service men spread over the Pacific Ocean during the latter half of the recent War. The descriptive section on the fishes is illustrated by a number of clear line drawings which are probably of even greater practical value than the photographs which illustrate the section on molluscs. The authors make no attempt to give a complete survey of these groups, but enough detail is provided for anyone to allocate a fish or mollusc to its family or genus. The book is, however, by no means confined to systematics; there are chapters on the origin and distribution of the fishes, on game fishes, and on the collection and preservation of fishes and molluscs.

In the section on molluscs there is a concise account of the chemical and physical factors in the sea, with a discussion of the part played by molluscs in the economy of the sea. There is a good short bibliography appended to the mollusc section of the book, but unfortunately there are no further references on the fishes.

Further popular books of this standard, covering other areas of the world, would be of great value, perhaps even in Great Britain, where many animal groups are still served by handbooks rapidly approaching their centenary.

Nuts

Their Production and Everyday Uses. By Dr. F. N. Howes. Pp. 264+16 plates. (London: Faber and Faber, Ltd., 1948.) 18*s*. net.

THIS is one of those useful books which present simply and shortly all but the more specialized aspects of one particular and comparatively limited subject—in this case the seeds and fruits that are popularly called 'nuts'. Apart from short introductory sections about the uses of nuts for food and their processing and storage, and an end section of cooking recipes, the book is in four parts, dealing respectively with tropical nuts, temperate nuts, nuts in Great Britain, and less familiar sorts. It is well produced and printed, and the illustrations as good as can be expected with such a subject.

As the author says, "most people relish nuts", especially children, and it is interesting to speculate how far this may come from the earliest days of human history when, it seems likely, nuts were one of the chief sources of food, especially in the warmer forest areas, where, indeed, they are still of much greater importance than elsewhere. Another interesting point is the way in which the book illustrates how various are the circumstances which may make or mar a vegetable commodity for purposes of modern commerce, a fact that may, in part, explain why the commercial plant-products of really first-rate importance are so few. Keeping qualities, the presence of unpalatable substances, the thickness of shells, the clinging of skins, the growth-form of the plant, the length of generation, and difficulties of harvesting or processing are but a few of the reasons why, among nuts at any rate, it seems that "the best is still to come".

Dr. Howes no doubt found it difficult to weigh fairly the claims to space of his different subjects, and on the whole he has kept a reasonable balance; but some disturbance of it might have been justified to allow consideration of so topical a matter as the African groundnut scheme. The statement, too, that this plant, which is assumed to be a native of America, has been cultivated in the Old World for "many centuries" is likely to raise some unnecessary hares. There might also be a more consistent insertion of the names of the families to which the various nuts mentioned belong. A detail of the book which is likely to appeal particularly to readers in Great Britain is the interesting account given of garden almond-trees. These often fruit surprisingly well, even on the rigorous north-east coast, where last year, for example, individual trees bore as much as thirty pounds of good fruit; Dr. Howes' reminder that the nuts from these fruits are usually perfectly palatable and wholesome is timely.

RONALD GOOD

Physics and the Surgeon

By H. S. Souttar. Pp. vii+60. (Oxford: Blackwell Scientific Publications, Ltd., 1948.) 7*s*. 6*d*.

THE mention of physics in any assembly of surgeons or physicians can be relied upon to arouse an immediate feeling of apprehension. An outstanding exception to this attitude is Mr. Souttar, who, besides being a surgeon of international standing, has acquired considerable repute as a physicist and mathematician. Unfortunately, the hopes raised by this combination of title and author are doomed to disappointment. The first half of the present book deals mainly with the mechanics and hydrostatics of human anatomy. There are fascinating accounts of the forces involved in muscle action, though the author is often so carried away in descriptive anatomy that the physics is left far behind.

The remainder of the book is devoted to atomic physics. In about thirty pages the reader is carried from the Rutherford atom, through the quantum theory, spectra, X-rays and radioactivity, taking in the cyclotron and isotopes in his stride. One is rather surprised to find that in a book dated 1948 the word 'neutron' appears only once, and the only instrument for detecting atomic particles mentioned is the spinthariscope. The many applications of atomic physics to surgery and medicine are not mentioned.

This book would need considerable expansion and revision in order to fulfil the promise of its title.

J. E. R.

THE UNIVERSITY COLLEGE OF THE WEST INDIES

MR. CREECH JONES, the Secretary of State for the Colonies, announced in January that a Royal Charter had been granted incorporating the University College of the West Indies, that the King had consented to accept the office of 'visitor', and that Princess Alice, Countess of Athlone, had been appointed the first Chancellor. The College does not possess power to grant degrees; its students will sit for the degree examinations of the University of London, until it has fully established its academic reputation and standards. The constitution has been so drafted that only minor changes will be needed when the College reaches the stage at which it feels justified in seeking university status.

The University College now enjoys full constitutional autonomy. The academic staff is strongly represented on the governing Council, and the Senate's control of academic policy is protected by the provisions of the Charter. The College has been admitted to the privilege of the "special relationship" with the University of London, which permits the teaching staff to propose changes adapting the curriculum to local opportunities and needs and to participate in the examining. This relationship guarantees the standard of the degrees, and at the same time gives the College a wide measure of freedom in linking teaching and examining to the research interests of the staff and to the special conditions of the West Indies. By this constructive co-operation with the University of London, the College will be enabled more quickly to work out the appropriate form which the local degrees should take when independent university status is achieved.

In the financial sphere, steps are similarly being taken to give maximum freedom to the College. Without endowments, it is at present dependent for its capital needs on grants from the Imperial Government, and for its recurrent income on contributions from the seven local governments. Devices for avoiding the possible dangers of this dependence, which have proved effective in the United Kingdom, have been adopted. The capital voted for the College under the Colonial Development and Welfare Act may amount to £1½ million, and is administered on the advice of a Colonial University Grants Committee predominantly academic in its composition. The local contributions are given as block grants, not earmarked in details, and as soon as the recurrent needs of the College can be more accurately forecast, they are likely to be given for three- or five-year periods at a time on the model of the quinquennial grant system for the universities of Great Britain.

The general plans for the College were sketched in the report of the Committee under Sir James Irvine which made an extensive tour of the Caribbean in 1944. The Committee recommended that the College should be unitary, residential and located in Jamaica. Although some of the seven territories must have been disappointed that they were not to be hosts to the College, there has been the fullest support from all, and the College is emerging as one of the first 'federal' institutions in the British West Indies. Student admissions are made not on a territorial quota basis but by competition; scholarships and the payment by the College of return passages to Jamaica ensure that candidates are not at a disadvantage through poverty or residence in an island remote from Jamaica. Jamaica has responded generously to its obligations as host to this West Indian institution by presenting a superb site of nearly 700 acres lying between the Blue Mountains and Long Mountain, six miles from Kingston, and by undertaking to meet a substantial part of the cost of an entirely new hospital which is being built on the site as the teaching hospital for the College medical school.

The inter-territoriality of the College has been emphasized by the work of its Department of Extra-Mural Studies, which began shortly before the internal teaching. Six of the seven full-time resident tutors have already taken up their duties in the territories to which they have been assigned; training courses for part-time tutors have been conducted by a specialist lent by the Oxford Extra-Mural Delegacy; and for the twenty-six classes in Jamaica in the autumn term of 1948 there were 1,200 students enrolled.

On the College site in Jamaica there is an extensive hutted camp, some parts of which have been adapted into temporary laboratories, halls of residence, library, students' union and staff accommodation. Designs for the permanent College and Hospital buildings by the architects, Messrs. Norman and Dawbarn, are well advanced, and it is expected that the contractors will begin work on the site within a few months. The availability of the temporary huts has made it possible for teaching to begin on a small scale; thirty-two students, including nine women, were admitted to the Faculty of Medicine in October 1948. A similar number will be admitted for the session 1949–50, together with about twenty-five students in the Faculty of Science. The Faculty of Arts will open in 1950 or 1951, depending on the progress of the permanent buildings.

The progressive stages in the starting of teaching has dictated the programme of staff appointments. The principal, Dr. T. W. J. Taylor, the director of extra-mural studies, Mr. Philip Sherlock, and the registrar, Mr. H. W. Springer, were appointed in 1946–47, the librarian, Mr. Harold Holdsworth, formerly of the Universities of Leeds and Cape Town, in 1948. The professor of botany, Dr. G. F. Asprey (formerly of the University of Aberdeen), the professor of zoology, Dr. Norman Millott (formerly of the University of Manchester), the professor of chemistry, Mr. C. H. Hassall (formerly of the University of Otago, New Zealand, and a research student at Cambridge), and the senior lecturer in physics, Mr. F. H. Bowen, took up their appointments early in 1948. Dr. W. F. Harper (London Hospital Medical College, University of London) has recently been appointed to the chair of anatomy, and Dr. I. F. Mackay (University of Durham) to the chair of physiology. Junior appointments have been made from the United Kingdom, Canada, South Africa and New Zealand. Of the twenty members of staff already appointed, eight are West Indians.

The importance attached by the College to the development of research is illustrated by the fact that it has already established one of its institutes, that for economic and social research, with Dr. H. D. Huggins as director. Undergraduate teaching in the social sciences may have to wait until the work of the Institute has begun to systematize the relevant data, to define some of the trends and problems of

economic and social developments in the Caribbean, and to prepare the way for publications and other teaching material.

The University College of the West Indies faces many problems, such as its need for further funds and endowments and the task of building up its library resources at a time of famine in books; but the speed and efficiency with which it has developed in its first two years augur well for its further progress.

BUILDING RESEARCH IN GREAT BRITAIN

THE work carried out at the Building Research Station under the direction of the Building Research Board is well known to all those interested in the design and construction of civil engineering works of every kind and size, and the appearance of the first report of the Board* after the interruption caused by the War is very welcome.

The report covers the period 1940–45, and is divided into two parts, the first of which deals with the normal programme of research in progress in 1945. The second gives an account of the work carried out at the Building Research Station during the War, but contains much information capable of more general application. Finally, there is a classified list of technical publications by the Board and by members of the staff of the Station, which provides a useful guide to current literature. The field covered by the report is very wide, and the space devoted to each aspect of research is necessarily brief; but enough information is given to make clear the method of research and the results obtained.

The first section of the main body of the report deals with investigations into structural materials. The Station has collaborated in a technical survey of the brick-making industry, the testing programme for which was completed in 1945. Work on cement and concrete has dealt with the suitability of different types of limestone aggregates for roads, and with various light-weight concretes. Methods of steam curing have also been studied, and a programme of tests has been carried out at a factory making precast concrete products, to examine the degree of control of quality attainable. Methods which have been developed for determining the specific surface of cements by measurement of air permeability or by nitrogen absorption are likely to be applicable to many other fine powders, and have already been used for some industrial materials.

Perhaps the most generally interesting part of the Station's work is that dealing with the design of domestic buildings. Here the investigation falls into two parts, the first dealing with structural tests on non-traditional methods of construction, and the second with heat insulation, lighting, plumbing and ventilation. The experimental work was carried out on complete houses built for the purpose on land adjacent to the Station. These were then let to tenants whose daily experiences will provide a check on the conclusions reached experimentally. This work is to be continued and extended. Before leaving the subject of house construction, mention must be made of the committees set up by the Ministry of Works to study various aspects of post-war building. The Station was responsible for five of these committees, and provided assistance to others.

Another major investigation is that which started in conjunction with the Ministry of War Transport into the behaviour under load of composite bridge deck systems. The approach to this problem is of interest as indicating the systematic methods adopted by the Station when dealing with complex practical problems. The mathematical analysis is complicated and lengthy, and a series of full-scale tests to cover the whole field is obviously impracticable. The analysis will therefore be accompanied by a number of tests on small models, and the results from these will be compared with those obtained from a few larger models and from actual bridges, thus indicating whether any special conditions of restraint which occur in actual structures have been left out of consideration in the laboratory tests.

Other tests made on existing bridges to determine their suitability for the heavy traffic of war-time showed that many old bridges could safely carry a load of two or three times their 'safe load' as estimated by the usual methods. It was also found that in no case did the dynamic stress caused by a travelling load exceed by more than 30 per cent that produced by the same load at rest.

In connexion with these and other tests, much work has been done on the development and use of the acoustic strain-gauge and the wire-resistance strain-gauge. The acoustic gauge has been found to be particularly valuable both for field and laboratory work, and a method of measuring dynamic strains with it has been worked out. The description of the mobile instrument laboratory is of interest.

Work on soil mechanics has been directed mainly towards the general problem of house foundations. In particular, the cracking and settlement of dwelling houses on clay has been studied, and types of foundation design have been evolved which should prevent this trouble. A point of interest is the discovery that fast-growing trees, such as poplars and elms, may cause serious cracking at distances of as much as 50 ft., owing to the withdrawal of water by their roots.

Studies have also been made of the soil conditions on the sites of several large new civil engineering works. One of the most interesting is the comprehensive investigation carried out in connexion with the proposed Flood Protection Scheme in the Fenland.

The war-time work of the Station ranged from the examination of possible substitutes for scarce materials, such as the use of synthetic bauxite in the manufacture of aluminous cement, to model tests of the effect on structures of explosions in earth, air and water. One of the most spectacular was the destruction of the 1/20-scale model of the Mohne Dam. The success of the air attack made in 1943 upon the actual dam is well known.

A war-time development which will be of permanent value was the establishment of a sound basis for the design of reinforced concrete railway-sleepers. Measurements were made of the load transmitted to the sleeper during the passage of the train, using a robust and compact weighing-device, which, after removal of a chair, could be placed between the rail and sleeper without disturbing the foundation of the tracks. The distribution of pressure under the sleeper was measured by placing between it and the ballast a 'ball sandwich', composed of two steel plates between which were 150 or more hardened steel balls.

* Department of Scientific and Industrial Research. Report of the Building Research Board, with a Report of the Director of Building Research for the Years 1940–1945. Pp. viii+112. (London: H.M. Stationery Office, 1948.) 3s. 6d. net.

By measuring the indentations made by these, the load distribution could be determined.

The risk of fire is present both in peace and war, and has been studied by the Station from several points of view. The effect of heat on the strength of concrete and other structural materials has been examined. Tests have been developed to evaluate the degree to which different wall-coverings contribute to or retard the rapid spread of fire. The principles of lay-out to prevent the spread of fire by radiation between buildings have been worked out.

It has only been possible to refer to the more important items discussed in the report; but it will be seen that the range covered includes something of interest to anyone concerned with civil engineering construction. It is satisfactory to learn from the introductory report of the Board that the importance of the Station's work has been recognized by the recruitment of additional staff and the provision of further facilities for research.

MOON ECHOES AND PENETRATION OF THE IONOSPHERE

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NORMAL ionospheric sounding technique can provide information on only the lower portion of the *F*-region, since waves capable of reaching beyond the level of maximum ionization are not returned to earth by any processes occurring within the ionosphere itself.

The reception of solar and cosmic radio noise at the earth's surface demonstrates that radio energy of sufficiently high frequency can penetrate the ionosphere, but unexpected ionospheric effects are sometimes found in records of 60 Mc./s. solar noise near sunrise. For a study of transmission right through the ionosphere, a signal from a controlled source is to be preferred to the highly variable emissions from the sun. It was thought that signals reflected from the moon might be used in this way for investigation of the ionosphere, and a series of exploratory tests was therefore undertaken.

Moon echoes were first obtained by the U.S. Army Signal Corps[1] and by Bay[2] early in 1946, in the metre wave-length region. The American observers reported large amplitude variations, which may have been due to ionospheric effects. For a specific study of the ionosphere it is desirable to work at lower frequencies, and it has been possible to use facilities already available in Australia for preliminary tests at these frequencies.

The results obtained to date may be summarized briefly as follow:

(1) Echoes from the moon have been obtained on thirteen out of fifteen attempts.

(2) The amplitude of the echoes was sometimes of the order expected on theoretical grounds, but more commonly it was considerably less.

(3) As the moon rose, echoes could not be obtained until the moon's angle of elevation was higher than was expected from calculations based on vertical-incidence ionospheric soundings.

(4) Analysis of 20 Mc./s. solar noise also shows ionospheric effects, with the significant difference that solar noise energy has been received at lower elevations of the sun than expected.

Experimental Arrangements

On several days each month, the moon passes through aerial beams used by the high-frequency broadcasting station Radio Australia for regular transmissions to the United States and Canada. This station is located in Shepparton, Victoria. With the co-operation of the Postmaster-General's Department, arrangements have been made for the use of a transmitter at this station when it is not required for broadcasting. The transmitter is pulsed by land-line from the Radiophysics Laboratory receiving station at Hornsby, New South Wales, 380 miles away. The electrical characteristics of the system used in the preliminary tests are summarized below.

Transmitter: *VLC*9, 17·84 Mc./s., 50 kW. output, or *VLB*5, 21·54 Mc./s., 70 kW. output.

Receiver: R.C.A. type *AR*88 communications receiver, with the band-width adjusted to 70 c./s. The stability with regulated supplies was such that slight retuning was necessary every 10–15 min.

Transmitting aerial: 16-element broadside array, with maximum of beam at 63° azimuth, 9° elevation, and first minimum in vertical plane at 23½°. Gain over an isotropic radiator, 22 db.

Receiving aerial: Rhombic aerial system, directed towards the region of the sky illuminated by the transmitting aerial. Beam steerable over a limited sector in the horizontal plane. Calculated gain over an isotropic radiator is 17 db. at 17·84 Mc./s.

Display: (*a*) Long-persistence cathode-ray tube, and photographic recording. (*b*) Loudspeaker, using the beat-frequency oscillator of the receiver. The aural method was the more sensitive for detection of weak echoes.

Keying procedure: The most frequently used keying signals were: (*a*) A group of three ¼-sec. pulses (for identification of weak echoes). (*b*) A single pulse 2·2 sec. long (for studying short-period amplitude variations of the echo, which began to appear 2·6 sec. after the start of the transmitted pulse). The pulse repetition period was 6 sec.

Owing to the use of fixed aerials, observations are possible only when the moon is within the beam of the aerials, ionospheric conditions are suitable, and 'Radio Australia' is not required for broadcasting. The moon passes through the aerial beam on several successive days for two periods each month, at times related to sidereal time and hence varying with respect to solar time. The transmitters are available only during 0230–0530, 0930–1230 Eastern Australian Standard Time. In the latter period, the critical frequency of the F_2-region is usually too high for penetration to be possible. Hence the working time of the system is restricted to days when the moon is in the required part of the sky between 0230 and 0530, that is, to about twenty days in a year.

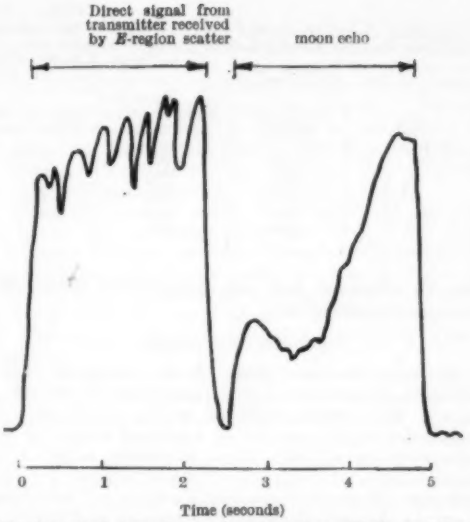
Echo Characteristics

Observations have been made in the 0230–0530 period on thirteen days, moon echoes being received on twelve of these for an average time of forty minutes. The less suitable 0930–1230 period was used only on two magnetically disturbed days, on one of which echoes were received.

The echoes have shown considerable amplitude variation. First, their strength was found to be much less on some nights than on others. The maximum amplitudes for the various runs, after correction for aerial performance at the angles concerned, showed a variation of more than 20 db., considerably greater than the experimental uncertainty.

Secondly, within a single test the mean amplitude taken over several minutes varied widely. This type of variation showed periods of 5–20 min. For example, on one occasion the echoes were strong enough to overload the receiver during the signal peaks for about 10 min., and then the intensity fell to a barely audible level for a time. Observations normally began shortly after moonrise, echoes being first received when the moon had passed out of the '*F*-region shadow'. The first appearance of the echoes was usually fairly sudden. From the accepted picture of the ionosphere, it might be thought that once echoes had been detected the amplitude would then depend mainly on the polar diagram of the aerial, as the moon elevation increased. In some of the tests the mean amplitude of the echoes varied in this way, but in most cases large amplitude variations of the type mentioned above were superimposed on the variation due to the aerial. On some occasions the echoes were lost completely after a short time, although the moon was still in the aerial beam; on others they faded in and out several times during the period of observation. A striking example of this occurred on March 14 during an ionospheric disturbance. On this occasion moon echoes were received for 23 min., and then lost for 30 min. before being detected again just as the moon was leaving the aerial beam.

Thirdly, considerable short-period fading has been observed. Using the three-pulse system (quarter-second pulses a half-second apart), it was quite common to receive only one or two echoes out of the group of three. An example of a record obtained with a 2·2-sec. pulse and showing a short-period fading is given in the accompanying figure. This fading with periods of less than a second is not unlike that observed in signals reflected from the ionosphere, and so may be mainly ionospheric in origin.



Tracing of photograph showing typical amplitude variation of moon echo during a single 2·2-second pulse. The small fluctuations on the echo trace represent cosmic noise (I.F. band-width = 70 c./s., video band-width = 6 c./s.)

Absolute Amplitude of Echoes

The echo cross-section of a large body is equal to the product of the projected area, the mean reflexion coefficient of the surface, and the directivity of the reflected energy in the direction of the transmitter. The reflexion coefficient depends on the dielectric constant, and the directivity on the shape and roughness of the surface. The strength of the echo from the moon was calculated from the standard radar equation, with reasonable assumptions concerning the reflecting properties of the moon.

The noise background at these frequencies consists mainly of cosmic noise. For a fixed low-angle aerial system, the cosmic noise-level varies with sidereal time and with ionospheric conditions. The noise temperatures at the times of the various tests were of the order of 10,000–20,000° K.

The calculated echo-strength was 30 db. above 15,000° cosmic noise, taking the moon at the centre of the aerial beam and neglecting ionospheric effects. In four of the thirteen tests in which echoes were received the maximum observed echo intensity, with suitable allowance from the theoretical aerial diagram, was within $\pm$ 5 db. of the calculated level. This is within the uncertainty of measurements with the equipment used in the exploratory work. In the other nine tests the maximum echo-strength was less by amounts of up to 20 db. On no occasion has the echo intensity exceeded the calculated level by more than the experimental uncertainty.

It cannot yet be said whether the reductions in intensity and the long-period variations are due to ionospheric, lunar or inter-planetary causes. Grieg, Metzger and Waer[3] seek to account for the amplitude variations in the American moon-echo experiments in terms of the interference fading produced by echoes from two or three 'bounce points' on the moon. Such a mechanism could produce short-period fading, but it is scarcely likely that day-to-day variations could arise in this way. If the echo intensity from the moon were predominantly due to reflexion from a few areas with favourable aspect, the echo would at times be expected to rise well above the calculated value for a rough sphere. No such high intensities have been found. An ionospheric origin for the slow variations seems more likely. Simultaneous reception of moon echoes at two points on the earth would provide evidence about the source of the variations.

Doppler Shift

The frequency of the received echoes was about 50 c./s. higher than that of the transmitted signal, the difference being clearly audible in the loudspeaker as a change in the note produced by the beat-frequency oscillator of the receiver. When the echo was sufficiently strong, it was possible to beat the two frequencies together. The frequency shift arises mainly from the Doppler effect of the earth's rotation, with smaller contributions from the moon's radial velocity, phase changes in the ionosphere, and variations in the effective centre of reflexion on the moon. An analysis of the effects of the various factors suggests that precision determinations of the shift and its time variations could be used to yield new information on the *F*-region. New determinations of certain astronomical and geodetic quantities could

Table 1. *F*-Region penetration

Conditions for the transmitted ray at the times of first detection of moon echoes, compared with the theoretical limiting angles for reflexion from the *F*-region back to ground. Following convention, angles of elevation and emission are measured from the horizontal, and angle of incidence from the normal to the *F*-region

Date (1947)	Frequency (Mc./s.)	Time of first detection of echoes (150° E. time)	Angle of elevation of moon	Theoretical minimum angle of emission for penetration	Observed maximum angle of incidence on F_2 for penetration	Theoretical maximum angle of incidence on F_2 for penetration
Nov. 7	17·84	0355	16·7°	12·2°	66·6°	69·8°
8	21·54	0348	10·7	6·2	70·4	72·3
9	21·54	0407	9·2	0	71·1	73·6
10	17·84	0502	14·9	0	67·3	74·5
Dec. 6	21·54	0234	13·5	8·2	69·3	72·2
7	21·54	0238	9·3	8·0	71·5	72·1

also be obtained, but only under very favourable ionospheric conditions.

Penetration Angles

A study has been made of the conditions under which the ionosphere is first penetrated, as the moon rises. The lowest angle at which echoes can be received is in the nature of a critical angle for the sensitivity employed. These minimum angles have been compared with the critical angles for the reflexion of waves from the *F*-region as calculated from the theoretical results of Appleton and Beynon[4].

Owing to the large distance between transmitter and receiver, the two directions of transmission through the ionosphere must be considered separately. *F*-region characteristics for the two estimated penetration points were derived from the vertical incidence data recorded every 10 min. at Canberra and Brisbane. From these were calculated the theoretical minimum angle of emission from the ground and maximum angle of incidence on the *F*-region for penetration. The theoretical minimum angle of emission was then compared with the elevation of the moon at the first detection of echoes, and the theoretical maximum angle of incidence compared with the angle of incidence on the *F*-region of a straight line from transmitter or receiver in the direction of the moon.

Under the conditions of the experiment, the elevation of the moon was about 5° less at Shepparton than at Hornsby. It is to be expected, therefore, that the elevation of the moon at Shepparton would determine the time at which echoes were first detected. As against this, a somewhat lower critical frequency was generally appropriate to transmission than to reception, in consequence of Shepparton's higher latitude. The difference in angles of elevation was found to be the more important effect, so that the limiting angles for echo-detection may be taken as those for the transmitted rays.

Table 1 presents the information on penetration conditions from the transmitter for the first six tests in which moon echoes were detected. It can be seen that echoes were not detected until the moon had risen well above the theoretical minimum angle of emission for penetration. Angle of incidence on the F_2-region is a more significant quantity than angle of emission. The table shows that the average difference between theoretical and observed limiting angles of incidence for penetration is 3°. This comparison refers to the angle of incidence on the F_2-region of a straight line from the transmitter to the moon. The angle of incidence of the penetrating ray will in general be less than this, as the ray path below the ionosphere will be closer to the normal than the ray path above, owing to the deviation which occurs in passing through a curved ionosphere. Under the conditions of the experiment, this deviation amounts to about 1–2° on current ionosphere theory. The effect is in such a direction as to increase the difference between the angle of incidence at which moon echoes might have been expected to appear and the angle at which they were first detected. Although the onset of the echoes was usually fairly abrupt, the maximum angle of incidence for penetration may not be as 'critical' as that for reflexion, and would possibly be reduced by the use of a more sensitive system.

Solar Noise

Information on penetration of the ionosphere is also obtainable from a study of solar noise. In the 20-Mc./s. region no general level of solar noise can be seen, but bursts often stand out from the cosmic noise background. Despite the sporadic nature of these bursts and their wide range of amplitude, useful results on penetration of the ionosphere can be obtained from the records. In contrast with the moon-echo results, it is not uncommon to receive solar noise bursts with the sun below the theoretical minimum elevation for penetration. Some examples are shown in Table 2. (The only theoretical results available on limiting angles for penetration are for the case of penetration from below.)

In comparing the evidence on ionospheric penetration obtained from moon echoes and from solar noise, two points must be remembered. First, in the echo experiments the limiting conditions were those for penetration of the ionosphere from below, whereas for solar noise, penetration was from above. The second difference is that the amplitude range for detectable solar noise bursts is greater than that for detectable moon echoes. Hence, if the cut-off at the *F*-region shadow were not sharp, high-intensity solar noise bursts could be seen at lower elevations than is possible for moon echoes. Present evidence sug-

Table 2. Examples of reception of solar noise bursts with the sun below the theoretical *F*-region shadow angle, as calculated from vertical incidence data

Date	Frequency (Mc./s.)	Time of reception of burst from sun (150° E. time)	Angle of elevation of sun	Theoretical minimum elevation for reception of penetrating rays	Observed angle between straight line from sun to receiver and normal to lower side of F_2	Theoretical maximum angle between penetrating ray and normal to lower side of F_2
July 10, 1947	18·3	1039	30·8°	37·2°	55·9°	50·2°
July 16, 1947	18·3	0938	24·9	31·5	61·0	55·3
April 16, 1948	18·3	1526	23·6	37·4	62·2	50·2

gests, however, that the cut-off is fairly abrupt, leading to the conclusion that transmission through the ionosphere in the two directions, from below and from above, appears to be different. Such lack of reciprocity could arise from the effect of the earth's magnetic field.

The work described in this paper is part of the research programme of the Division of Radiophysics, Council for Scientific and Industrial Research, Commonwealth of Australia.

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OBITUARIES

Dr. F. H. A. Marshall, C.B.E., F.R.S.

BORN at High Wycombe on July 11, 1878, Francis Hugh Adam Marshall died suddenly after an operation in a Cambridge nursing home on February 5. He was the younger son of Thomas Marshall, and was educated at St. Mark's School, Windsor, and privately. After a short time at University College, London, he went up to Christ's College, Cambridge, in 1896 and took the Natural Sciences Tripos. Inspired by the work of Walter Heape in Cambridge on sex physiology, he then accepted an invitation to work in Edinburgh with Prof. Cossar Ewart, who at that time was conducting his well-known experiments on telegony in farm animals at Penicuik. Here he started his research career and worked in conjunction also with the distinguished group of research physiologists centred around Sir Edward Sharpey Shafer. During this time he published many valuable papers on the œstrous cycle in the sheep (1903), the ferret (1904) and the dog (1905); but perhaps one of the most important was that on "The Ovary as an Organ of Internal Secretion", for it led to large developments in this field later. The University of Edinburgh honoured him with a D.Sc. and later with an LL.D. degree, and he was elected a fellow of the Royal Society of Edinburgh.

In 1908 Marshall returned to Cambridge, where he became lecturer in agricultural physiology in the newly formed School of Agriculture. He was also elected a fellow of Christ's College and lectured to medical students in the Department of Physiology on reproduction. It was during these years that he gathered the materials for and wrote his classical book on "The Physiology of Reproduction", which was first printed in 1910, a second edition appearing in 1922. This book appeared at an opportune time, for during that period research work was expanding rapidly in the United States and elsewhere, and the book, giving complete references to the literature on the subject, formed a background for the spectacular advances made later on the internal secretions of the reproductive organs, a subject to which much of Marshall's earlier work was devoted. At the time of his death he was busy with proofs of the third edition of this book, chapters for which had been contributed by many of his former pupils and associates whom he had inspired by his passionate devotion to his subject.

In the period of some thirty-five years during which he was lecturer, and afterwards reader, in agricultural physiology at Cambridge, he also laid the foundation for this subject as a basis for training in animal husbandry, and his book on the "Physiology of Farm Animals" is widely used and has run through several editions. In conjunction with the late Prof. T. B. Wood, the first director, he helped to develop the Institute of Animal Nutrition at the School of Agriculture, Cambridge, and became director himself for a short time after Wood's death. For his work for agricultural science he was made a C.B.E.

Marshall's literary talents were well developed and he wrote with a clarity and ease of style which held the attention of his readers. These powers he put to good use not only in his books but also as editor of the *Journal of Agricultural Science* and as a founder member of the editorial boards of the *British Journal of Experimental Biology* and the *Journal of Endocrinology*.

In 1920 he was elected a fellow of the Royal Society and served on the Council from 1933 until 1935. In the following year he delivered the Croonian Lecture on "Sexual Periodicity and the Causes which Determine it", in which he stressed the exteroceptive factors, especially of light, a subject on which he did much experimental work in his later years. He was awarded a Royal Medal in 1940.

At Cambridge Marshall played his part, too, in academic affairs, becoming tutor, dean and finally, in 1940, vice-master of Christ's College. He was a proctor during 1911–12 and afterwards served on the Council of the Senate. His kindly and gentle manner endeared him to his students and to the many aspiring research workers who came to seek his advice from far and wide.

JOHN HAMMOND

Prof. L. Farkas

THE death of Ladislas Farkas, at the age of forty-four, removes from our midst a relatively young physical chemist of singular charm and undoubted ability.

Ladislas Farkas was the younger son of a Hungarian pharmacist living at Dunaszerdahely, and, like his elder brother, revealed a particular aptitude for physical chemistry. He attended the Technische Hochschule in Berlin, and then worked with Prof. Fritz Haber at the Kaiser Wilhelm Institut in Berlin-Dahlem at the period when the possible participation of atoms and radicals in chemical reactions had been recognized and demanded intensive investigation. His work here was so effective that he was promoted to 'assistant'. As the Nazi regime in Germany became more definitive, he found his position becoming more difficult, and he emigrated to work in the Department of Colloid Science at the University of Cambridge.

Deuterium, at that time, was scarcely obtainable in Britain, and its obvious utility, on account of the mass and zero point energy differences, in throwing light on the detailed mechanism of homogeneous, heterogeneous and catalytic reactions, suggested a promising field for inquiry. Farkas prepared deuterium compounds by the orthodox electrolytic and diffusion processes, and in addition elaborated a number of ingenious partition and chemical methods for its separation. The results of the investigation of a number of chemical and catalytic reactions, in which hydrogen and hydrogen-containing compounds were replaced by deuterium, were presented in a series of papers. His experimental work was characterized by elegance in design and execution, while his theoretical insight, already appreciated by Haber, was confirmed by his British co-workers.

Before the Second World War, when the Hebrew University of Jerusalem was undergoing extension, Farkas, at the request of Dr. Ch. Weizmann, joined the staff there and was appointed professor of physical chemistry in 1936, a post which he held at his death. During the last ten years he was particularly active in training young chemists in Israel. Early in 1942, the Palestine War Supply Board set up a scientific advisory committee to co-operate with the Middle East Supply Centre in Cairo, and Farkas became its scientific secretary. He developed methods for the local production of many important chemicals such as ethyl chloride, ethylene bromide and vitamin D.

He took an active part in the exploitation of the Dead Sea minerals, particularly the recovery and utilization of bromine.

At the end of December Farkas left Jerusalem for the United States to purchase scientific equipment, and on this journey he was the victim of an aeroplane crash in the vicinity of Rome. ERIC K. RIDEAL

WE regret to announce the following deaths:

Dr. Tenney L. Davis, emeritus professor of organic chemistry in the Massachusetts Institute of Technology, and editor-in-chief of *Chymia*, an annual publication devoted to historical chemistry, on January 25, aged fifty-nine.

Prof. T. S. Patterson, Gardiner professor of organic chemistry in the University of Glasgow, on February 14, aged seventy-six.

NEWS and VIEWS

Department of Scientific and Industrial Research: Sir Edward Appleton, G.B.E., K.C.B., F.R.S.

THE appointment of Sir Edward Appleton to be principal and vice-chancellor of the University of Edinburgh was announced in November last, and he will be taking up his new duties there in May. Sir Edward became secretary of the Department of Scientific and Industrial Research in February 1939, after a brilliant university career, during which he conducted his classical researches on the transmission of radio waves which led to the award of the Nobel Prize for Physics in 1947 (see *Nature*, November 22, 1947, p. 703). During the ten years he has been with the Department of Scientific and Industrial Research, Sir Edward has devoted all his energy to its interests and purposes. These are broadly: first, to seek scientific truth by carrying out research in the Department's establishments and by encouraging programmes of research in other appropriate places; and secondly, to foster the application of scientific knowledge for the benefit of the community. This period of service has included the arduous war years during which the duties and responsibilities of the head of the Department were particularly onerous and of vital importance to the nation. As an administrator, Sir Edward has come to be respected by all the staff who worked under him; as the Civil servant who represented the Government in all branches of science, except medicine, agriculture and fisheries, he has commanded the attention and appreciation of the whole of Britain. His wisdom, shrewdness and gentle, but persuasive, drive have made him much sought after as chairman of national committees of all types, whether these were concerned with scientific or technical matters or with the practical details of staffs and their organisation. Throughout his decade of Government service, Sir Edward has succeeded in maintaining a close and active interest in the field of radio science which he has made his own and for which he has an international reputation. There is little doubt that, while in his new position he will naturally be mainly concerned with university administration, he will find opportunities to continue his favourite line of research work.

Sir Ben Lockspeiser

SIR BEN LOCKSPEISER, who succeeds Sir Edward Appleton as secretary of the Department of Scientific and Industrial Research, was born in 1891. He was educated at the Grocers' School, London, and Sidney Sussex College, Cambridge. He served in the First World War, taking part in the Gallipoli Campaign. Invalided home, he worked under Prof. A. V. Hill on problems relating to fuses. His association with aeronautics started in 1920, when he went to the Royal Aircraft Establishment, Farnborough. He was at first engaged in research on crystal structures with Dr. A. A. Griffith; later he worked on aerodynamics and instrument design. He made valuable contributions to the theory of aircraft flutter and to the development of a chemical method of de-icing. He was placed in charge of the Air Defence Section at the Royal Aircraft Establishment in 1937, and it was perhaps in this that his best work, most of it secret, was done. He was transferred to the Ministry of Aircraft Production to take charge of armament research, being made assistant director in 1939 and deputy director in 1941; he became director of scientific research in succession to Dr. D. R. Pye in 1943, and director general in 1945. When the Ministry of Supply took over the responsibilities of the Ministry of Aircraft Production for aircraft, the need for a man of science to co-ordinate the scientific investigations of the whole Ministry was apparent, and Sir Ben was appointed as chief scientist to take over this work. Throughout his career Sir Ben has taken a strong interest in the status of scientific workers in the Civil Service; much of the improvement in conditions of service that has been achieved is due to his untiring efforts.

Physiology at University College, London: Prof. C. Lovatt Evans, F.R.S.

PROF. CHARLES LOVATT EVANS is retiring at the end of the present session from the Jodrell chair of physiology at University College, London, which he has occupied since 1926. He was originally a student and is now an honorary LL.D. of the University of Birmingham. He then went to University College as Sharpey Scholar in Starling's laboratory and qualified in medicine at University College Hospital. As a fellow of the College, as professor and as dean of the Faculty of Medical Sciences, he has spent a large part of his active life in the place. As a member of the Medical Research Council, of the council of the Royal Society (vice-president), of the council of the Royal Veterinary College and of many other bodies,

as an experienced examiner at home and overseas, he has made many important contributions not only to original knowledge but also to the structure and organisation of medical, dental and veterinary science and education. During both World Wars his skill in physiological experiment found valuable full-time application to chemical warfare and personnel research. But Starling's laboratory and Starling's inspiration, as he would proudly acknowledge, have made University College his real home. He and Mrs. Lovatt Evans will be sorely missed.

Lovatt Evans is a physiologist of the kind, now becoming rare, with a wide and critical knowledge of the whole field of human physiology. An excellent chairman and lecturer, a wise and understanding colleague with familiar contacts with physiologists the world over, his help and advice have been sought, and will continue to be sought, by those who have problems to solve, gaps of knowledge to make good —or posts to fill. One of his most important services to physiology has been in keeping alive and up to date Starling's "Principles of Human Physiology", an immense and continuing labour to which he has added the authorship or editorship of other books and monographs. The admirable performance of this task depended on, and perhaps added to, the breadth of his knowledge. Lovatt Evans, although retiring this year, is young in mind and activity, and physiologists will expect him to continue as busy as ever in the service of physiology.

Lovatt Evans's own original work has been largely concerned with the circulatory system: heart, lungs, blood, oxidation, frequently with a bias towards the metabolic and chemical side (his early love was chemistry). But among a wide range of interests are also numbered liver function, sugar metabolism, blood *p*H, lactic acid, adrenalin, etc. A suggestion he once made, probably forgotten by him, based on his knowledge of plain muscle, fired off an important train of research on the function of potassium in striated muscle and thence in non-medullated nerve. Some of the best things start, apparently casually, by suggestions of that kind, and Lovatt Evans's wide knowledge must have been responsible for many; his pupils and his friends owe much to him and them.

Dr. G. L. Brown, C.B.E., F.R.S.

Dr. G. L. Brown, who has been appointed to succeed Prof. Lovatt Evans, has been a member of the scientific staff of the Medical Research Council for the last fourteen years. Dr. Brown was a student at the University of Manchester, where he graduated in medicine in 1927, having taken a higher degree in physiology during his course of study. He left Manchester to become demonstrator and later lecturer in physiology under the late Prof. McSwiney at Leeds, where his researches were concerned with the motor innervation of the stomach. When Dr. Brown went to the National Institute for Medical Research in 1934, he joined in the programme of work in Sir Henry Dale's laboratory on the chemical transmission of nerve impulses; to this work he made major contributions, especially in connexion with the role of acetylcholine in the conduction of impulses through sympathetic ganglia and from motor nerves to skeletal muscle. Since then he has much extended his researches in neurophysiology with full application and development of modern electrical methods; the results of his work are important not only for their scientific interest but also for their clinical applications. During the Second World War, Dr. Brown gave distinguished service, as secretary of the Royal Naval Personnel Research Committee, both by organising and directly stimulating researches on conditions affecting the efficiency of naval personnel. The chair at University College will thus be occupied by a man who has established himself as a leader in physiology, and who will undoubtedly uphold the great traditions of the Laboratory of which he will have charge.

Prof. Solly Zuckerman, C.B., F.R.S.

The Lord President of the Council has announced that Prof. Solly Zuckerman, a member of the Advisory Council on Scientific Policy and of the Committee on Industrial Productivity, has been appointed deputy chairman of both bodies. The appointment, it is stated, will help to relieve the burden on the chairman, Sir Henry Tizard, who is also chairman of the Defence Research Policy Committee. Prof. Zuckerman will continue as chairman of the panel on imports and as professor of anatomy in the University of Birmingham.

Operational Research in Industry

In reply to a question asked in the House of Commons on January 19 on operational research in industry, the Lord President of the Council, Mr. Herbert Morrison, stated that it is the policy of the Government "to encourage all scientific activities which contribute to increasing the productivity and efficiency of industry. Operational research . . . is a term given in the recent war to the use of the scientific method for obtaining data on which executive decisions can be based. It has been employed by progressive firms in many industries for a number of years; . . . there is certainly room for more of it. I have had a full report on its possibilities from a Panel of the Committee on Industrial Productivity. Several of the co-operative research associations, in particular the Cotton Research Association, the Iron and Steel Research Association and the Boot, Shoe and Allied Trades Research Association are doing well with it; and with the general expansion of facilities since the War, other research associations are already carrying out, or are planning, similar work." Mr. Morrison added that the Departments concerned will extend every encouragement to firms anxious to develop operational research within their respective organisations.

Submarine Geology: New French Annual

Oceanographers, who have long had good cause to be grateful to two well-known American institutions for their volume of "Collected Reprints" distributed each year, will welcome the recent institution of a comparable practice in France. It is manifestly impossible for individuals, and practicable only for a few major libraries, to maintain subscriptions and exchanges adequate to ensure the receipt of anything like all the important oceanographical papers which appear in the course of a year; a serious difficulty resides, of course, in the fact that so many organs of publication are concerned. This latter point is evident on scanning a new volume just received, *Travaux du Laboratoire de Géologie Sous-Marine*, vol. 1 (1947). This is produced by the École Pratique des Hautes Études, 1 Rue Victor-Cousin, Paris 5e, under the superintendence of the director, Jacques Bourcart. It contains fifteen papers; five are by Dr. Bourcart himself, of which

three are on the sediments of the French continental shelf, one on sedimentation in the English Channel, and the other on the geology of the 'Iles Atlantides'. A paper by B. Brajnikov on the origin of the alluvial deposits of the Seine estuary is followed by a series of three by Prof. A. Cailleux, of which one discusses criteria for distinguishing between marine and fluviatile gravels. Dr. Claude Francis-Bœuf, who is the author of five of the remaining papers, is well known for papers already published on the processes involved in estuarial sedimentation—a topic of great present-day importance. He discusses the physico-chemical factors of estuarial waters in connexion with the tropisms which affect eel migrations; sedimentation in estuaries; the oxygen content of fluvio-marine muds, and the production and consumption of oxygen in the topmost surface layer of the latter. The last paper, by V. Romanovsky, is on the elasticity of agar-agar gels. All the papers included are reprints from various publications; the practice of issuing annual fascicules of reprints in special branches of study is very valuable to those directly interested.

International Committee on Nomenclature of Ocean Bottom Features

THE International Union of Geodesy and Geophysics re-established, at its Oslo meeting in August 1948, an International Committee on the Nomenclature of Ocean Bottom Features under the chairmanship of Dr. J. D. H. Wiseman, British Museum (Natural History). The other members of this Committee are: Vice-Admiral J. D. Nares (*secretary*), International Hydrographic Bureau, Monaco; Dr. K. O. Emery, United States; Prof. H. H. Hess, United States; Prof. Hans Pettersson, Sweden; and Prof. Ph. Kuenen, Holland. The terms of reference of the Committee are: "To endeavour to establish in co-operation with the chart-making authorities, mechanisms for the International agreement on the nomenclature of submarine topographical features, as well as considering methods of presentation of marine topographical data on bathymetrical charts".

In order to facilitate the work of this International Committee, a British National Committee has been established under the chairmanship of Dr. J. D. H. Wiseman, with the following members: Mr. C. D. Ovey (*secretary*), British Museum (Natural History); Dr. J. N. Carruthers, Admiralty; Dr. L. H. N. Cooper, Marine Biological Association of Great Britain, Plymouth; Mr. H. F. P. Herdman, "Discovery" Investigations; Prof. W. B. R. King, Sedgwick Museum, Cambridge; Lieut.-Colonel R. B. Seymour Sewell, Zoological Laboratory, Cambridge; and Mr. J. A. Steers, president of St. Catharine's College, Cambridge. Early consideration will be given by this Committee to the various physiographical features found at the bottom of the oceans, and at a later stage to nomenclature and the presentation of data on bathymetrical charts. The British Committee would welcome and carefully consider any individual contributions or suggestion, which should be addressed to its secretary, Mr. C. D. Ovey, British Museum (Natural History), Cromwell Road, London, S.W.7.

Maternal Mortality in India

INQUIRIES into the causes of maternal mortality in Bombay, Calcutta, Delhi and Madras show that the data published in the reports of public health departments are unreliable and do not give an accurate picture of the real situation. These inquiries have been collated by Dr. S. Pandit in a report of the Indian Research Fund Association (No. 17; June 1948), and show that figures obtained by special investigations are considerably in excess of the numbers recorded in the public health reports. According to the reports of the executive health officer of Bombay, for example, the maternal mortality-rate for the year 1937 was 4·4 per 1,000 live births, whereas the rate determined by Dr. J. Jhirad for the same period was 13·5 per 1,000 live births. A clearer picture of the incidence of maternal mortality and of the causes responsible for it could be obtained only when a better system of recording all vital occurrences and of certification of the causes of death become widely established throughout India.

A statistical review of the figures collected during the investigations emphasizes the need for developing health services for prenatal care, adequate domiciliary and institutional midwifery services and close co-operation among the different agencies responsible for them. The reports recommend provision of facilities for institutional treatment for abnormal midwifery and puerperal sepsis cases. It is suggested that medical men and midwives in maternity services should have knowledge of preventive aspects of maternal care and, wherever possible, services of health visitors should be employed for educational and follow-up work. As anæmia forms one of the main causes of maternal deaths in India, its diagnosis and early treatment during pregnancy is of vital importance, and special attention should be paid to this condition. To improve the maternal health programme a service providing correct information on maternal deaths should be maintained and research into all aspects of maternal health should be conducted.

Fertility of Scottish Women

THE widely held belief that decline in fertility among women is directly related to the degree of urbanization which has taken place in a community is not borne out by investigations which have been made by R. S. Barclay and W. O. Kermack (*Proc. Roy. Soc. Edin.*, Section B, **43**, Part II, No. 9). Surveying the trends of fertility in various sections of the population of Scotland from 1860 onwards, they gave special attention to the comparison of urban and rural areas. Difficulties in assembling the statistics arose because of the alterations introduced from time to time in the basis of classification used by the Registrar-General; but these were overcome in various ways. The areas investigated were the four chief cities, Glasgow, Edinburgh, Dundee and Aberdeen, and two groups of counties, one typical of the Highlands (Sutherland, Ross and Cromarty, Inverness and Nairn), and the other typical of the Borders (Peebles, Selkirk, Roxburgh and Berwick).

The results show that the fall in fertility in Scotland set in at about the same time in both urban and rural areas and, broadly speaking, the trends have run closely parallel in these two sections of the community. The fall in the urban section was neither earlier nor more rapid than that in the rural section. Other interesting findings are that the trend of legitimate fertility in the Border group of four counties contrasts strikingly with the trend in the Highland group, the fall in fertility in the former having set in earlier and proceeded more rapidly, while the fall in legitimate fertility in Aberdeen appears to have set in about twenty years later than in the other three large cities of Scotland.

Bird-Ringing in South Africa

THE first ringing of South African migratory birds was made early in December 1948 when the Cape Bird Club, under the direction of Dr. G. J. Broekhuysen of the University of Cape Town, used specially designed nets to catch European waders on the mud flats at Muizenberg, and marked them with leg bands inscribed "Zoo-Pretoria". The ringing scheme is sponsored by the South African Ornithological Society and is being extended over the Western Province. The birds caught were weighed before marking and release. Little stints, avocets, Sandwich terns, curlew-sandpipers, stilts and other familiar British birds-of-passage and nesting birds are expected to figure prominently in the South African experiment, which will not only elucidate further details about the winter quarters of European waders, and shore birds, but also determine whether many of the birds found at the Cape remain in the Union throughout the year, or nest elsewhere in Africa. Certain species like the black-winged stilt not only migrate from European nesting haunts but also breed in parts of Africa.

For many years now migratory birds ringed in European nesting haunts have been recovered at winter haunts in Africa. Notable among these have been the European swallow, the house-martin, the common swift, the cuckoo, the nightjar, the red-backed shrike and the Sandwich tern and the white stork. More than a score of common swallows marked when nesting or as nestlings in the British Isles have been recovered in South Africa, and the Sandwich tern from Britain has been recovered in Natal.

Research at the University of Sydney

A COMMITTEE appointed by the vice-chancellor has prepared an interesting description of the original scientific work done at the University of Sydney during the years 1944 and 1945, so continuing the account set out in the previous publication for the years 1942–43. The report shows that, despite the absence of many members of staff on war service and the greater amount of teaching duties undertaken by those who remained at the University, much valuable work was carried out and a considerable number of young workers were trained to undertake research. Subjects of research are listed under the headings: art, law, medicine, science, engineering, veterinary science, agriculture, economics and social studies.

University of Leeds

THE Council of the University of Leeds has announced the receipt of the following gifts, among others: a sum of £200 given to Prof. S. Brodetsky by his friends on his retirement from the chair of applied mathematics and presented by him to the University for the establishment of a prize in mathematics; £1,500 given to the Inorganic and Physical Chemistry Department by the Royal Society for the development of a special Weissenberg goniometer.

The following appointments have been made: Dr. D. G. Christopherson, fellow and bursar of Magdalene College, Cambridge, to be professor of mechanical engineering from September 1, 1949, in succession to the late Prof. W. T. David; Mr. R. Holliday, to be senior lecturer in agriculture.

Royal Society Lectures for 1949

THE Croonian Lecture for 1949 will be delivered on June 30 by Dr. D. W. Bronk, foreign secretary of the National Academy of Sciences and chairman of the National Research Council of the United States. As director of the Johnson Institute for Medical Physics in the University of Pennsylvania, he has greatly influenced the development of biophysics, his special field of work being the physiology of the nervous system; his recent work has been on the oxygen consumption of the brain. The Croonian Lecture was founded by Dr. William Croone, one of the original fellows of the Royal Society, "for a lecture and illustrative experiment for the advancement of natural knowledge on local motion"; the first lecture was delivered in 1738.

The Bakerian Lecture for 1949 will be delivered on May 12 by Prof. H. Raistrick, professor of biochemistry in the University of London. This Lecture was founded by Mr. Henry Baker, "for a yearly oration or discourse by one of the Fellows on some part of natural history or experimental philosophy"; the first lecture was delivered in 1775.

The Wilkins Lecture for 1949 will be delivered on December 15 by Prof. E. N. da C. Andrade, Quain professor of physics in the University of London. The Wilkins Lecture on the history of science was founded in 1947 by Mr. J. D. Griffith Davies, a recent assistant secretary of the Society, who delivered the first lecture entitled "John Wilkins and the Royal Society" in 1948.

Goethe Bicentenary Lectures

A SERIES of six festival lectures in commemoration of the bicentenary of the birth of Goethe will be held at University College, London, under the auspices of the British Goethe Festival Society, beginning on March 3. The first lecture is by Prof. L. A. Willoughby, on "The Living Goethe". The remaining lectures are by Dr. G. P. Gooch, on "Goethe, the Liberal–Conservative" (March 10); Prof. F. Blume, "Goethe and Music" (March 17); Dr. Karl Wollf, speaking in German, on Goethe's religion (April 21); Prof. H. Friedmann, "Goethe's Morphology" (April 28); Mr. L. L. Whyte, "Goethe's Single View of Nature and Man" (May 5). The lectures are at 5.30 p.m. and are open to the public without fee or ticket.

First International Congress of Biochemistry

THE First International Congress of Biochemistry will be held in Cambridge during August 19–25, 1949. The Congress is under the presidency of Prof. A. C. Chibnall, and for the reading of papers and for discussion it is organised into twelve separate sections, each with its own chairman, as follows: animal nutrition and general metabolism, Sir Jack Drummond; microbiological chemistry (vacant through the recent death of Miss Marjory Stephenson); enzymes and tissue metabolism, Prof. R. A. Peters; proteins, Dr. K. Bailey; clinical biochemistry, Prof. E. J. King; structure and synthesis of biologically important substances, Prof. A. R. Todd; cytochemistry, Prof. J. N. Davidson; biological pigments: oxygen carriers and oxidizing catalysts, Prof. D. Keilin; hormones and steroids, Prof. F. G. Young; chemotherapy and immunochemistry, Sir Charles Harington; plant biochemistry, Dr. C. S. Hanes; industrial fermentations, Mr. H. J. Bunker. In addition to the meetings of the sections, there will be Congress lectures and visits to research stations and laboratories. The fee for membership of this Congress is £2. Applications and inquiries should be addressed to the Honorary Organiser, First International Congress of Biochemistry, 56 Victoria Street, London, S.W.1.

Conference in London on Prehistoric Homesteads

A CONFERENCE on "Prehistoric Houses and Farms, and Some Later Comparisons" will be held by the Prehistoric Society in collaboration with the University of London Institute of Archæology during April 22–24, 1949, at the latter's address at Inner Circle, Regent's Park, London, N.W.1. Admission to the Conference is free to members of the Society and of the Institute, and for all others the price of admission is 5*s*., inclusive for all days, tickets being obtainable at the door only. The honorary secretary of the Conference is Mr. T. G. E. Powell, Department of Prehistoric Archæology, University, Liverpool, 3.

Medical Research Council: Carcinogenic Action of Mineral Oils

THE Medical Research Council has appointed the following to advise and assist in the prosecution of research on the carcinogenic action of mineral oils: Prof. T. Ferguson, professor of public health, University of Glasgow (*chairman*); Colonel S. J. M. Auld, chairman of Research Group No. 2, Institute of Petroleum; Prof. J. W. Cook, regius professor of chemistry, University of Glasgow; Prof. A. Haddow, professor of experimental pathology, University of London, and director of the Chester Beatty Research Institute, Royal Cancer Hospital, London; Dr. J. O. Irwin, senior research worker, Medical Research Council Statistical Research Unit, London School of Hygiene; Prof. J. R. Squire, professor of experimental pathology, University of Birmingham; Dr. D. L. Woodhouse, officer-in-charge, Cancer Research Laboratory, University of Birmingham; Dr. J. M. Rogan, Medical Research Council Headquarters Staff (*secretary*). In addition, the Ministries of Fuel and Power, Health, and Ministry of Labour and National Service, have nominated representatives who will attend meetings when matters of interest to these departments are likely to arise.

Royal Astronomical Society: Officers for 1949

AT the annual general meeting of the Royal Astronomical Society held on February 11, Prof. W. M. Smart, regius professor of astronomy in the University of Glasgow, was elected president. The following were also elected officers of the Society: *Treasurer*, Sir Harold Spencer Jones; *Secretaries*, Prof. R. O. Redman and Dr. A. Hunter; *Foreign Secretary*, Prof. F. J. M. Stratton.

The Night Sky in March

FULL moon occurs on March 14d. 19h. 03m., U.T., and new moon on March 29d. 15h. 11m. The following conjunctions with the moon take place: March 13d. 06h., Saturn 3° S.; March 23d. 14h., Jupiter 5° N.; March 28d. 05h., Mercury 0·7° N. Mercury rises 45 minutes before the sun at the beginning of the month and 20 minutes before sunrise at the middle of the month, and is unfavourably placed for observation. Venus is too close to the sun during March for favourable observation. Mars is in conjunction with the sun on March 17 and cannot be seen during the month. Jupiter rises at 5h. 04m., 4h. 17m. and 3h. 22m. at the beginning, middle and end of the month respectively, and can be observed low down during the early morning hours in the constellation of Sagittarius. Saturn, in the constellation of Leo Major, can be observed throughout most of the night, setting at 6h. 45m., 5h. 45m. and 4h. 45m. at the beginning, middle and end of the month respectively. Occultations of stars brighter than magnitude 6 are as follow: March 5d. 21h. 49·3m., δ Arie. (*D*); March 6d. 18h. 40·3m., 33 Taur. (*D*); March 8d. 20h. 21·8m., 136 Taur. (*D*); March 10d. 22h. 24·8m., ω Canc. (*D*). *D* refers to disappearance, and the latitude of Greenwich is assumed. Spring equinox commences on March 20d. 23h.

Announcements

THE following elections have been made to the Paris Academy of Sciences: M. Constantin Dawidoff, to be *correspondant* for the Section of Anatomy and Zoology, in succession to the late Prof. Johan Hjort; M. André Donatien, to be *correspondant* for the Section of Rural Economy, in succession to the late M. D. Prianichnikov.

THE following appointments in the University of Birmingham have been announced: Dr. F. Morgan, to be reader in chemical engineering; Mr. M. Shaw, to be Tube Investments Research Fellow in the Department of Engineering Production. The following have been appointed lecturers in the subjects as indicated: Dr. G. M. Burnett (chemistry); Dr. W. G. Overend (chemistry); Mr. D. A. Bell (electrical engineering); Mr. J. C. Henderson (electrical engineering).

THE Council of the University of Sheffield has made the following appointments: Dr. Quentin H. Gibson, lecturer in physiology, to be senior lecturer in physiology; Frank A. Benson, lecturer in electrical engineering; Margaret Gunn, cancer research assistant (to work in the Department of Pathology under the auspices of the British Empire Cancer Campaign).

DR. C. WEST has relinquished the post of superintendent of the Ditton Laboratory of the Department of Scientific and Industrial Research on transfer to the headquarters of the Director of Food Investigations, 20A Regent Street, Cambridge, for special duty. He is succeeded by Dr. R. G. Tomkins, of the Low Temperature Research Station, Cambridge. The Laboratory will continue to work mainly on problems of preserving fresh fruit and vegetables by refrigeration.

THE trustees of the Ramsay Memorial Fellowships for Chemical Research invite applications before April 16 for these fellowships, one of which will be limited to candidates educated in Glasgow. The value of each fellowship will be £400 per annum, with a grant for research expenses not exceeding £100 per annum. Particulars can be obtained from the Joint Honorary Secretaries, Ramsay Memorial Fellowships Trust, University College, Gower Street, London, W.C.1.

THE second 'chemical day' at Clausthal will be held, under the auspices of the Harz Section of the German Chemical Society in the British Zone, during March 4–5.

ERRATA.—In the account in *Nature* of December 25, p. 985, of the Nutrition Society's meeting on "Anti-vitamins", Dr. L. J. Harris was incorrectly reported to have stated that the active principle of 'Gammexane' is hexachlorobenzene; it should be, of course, the gamma isomer of benzene hexachloride (hexachlorocyclohexane). The statement attributed to Dr. E. Kodicek that live yeast contains thiaminase is also incorrect.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Absorption of Star-Producing Radiation Under Ice

MEASUREMENTS of the absorption of the radiation responsible for the nuclear disintegrations observed in photographic emulsions have been made in the atmosphere and under lead. The star intensity I, at a depth h gm./cm.^{2} from the top of a medium, can be represented by

$$I = I_0 \exp(-h/l),$$

where l is the range of the star-producing radiation in gm./cm.^{2}.

Experimental ranges of 160 gm./cm.^{2} and 140 gm./cm.^{2} have been obtained in air by George[1] and Perkins[2] respectively. By considering the single tracks which accompany stars, and which in number he showed to be proportional to the number of stars, Perkins deduced a value of 320 gm./cm.^{2} for the range of the star-producing radiation in lead. He thus concluded that the stars are produced by unstable particles.

Considering the stars proper, George obtained a range of 310 gm./cm.^{2} in lead and suggested that the increased range in lead compared with that in air could be explained by the different atomic weights of the absorbers, instead of by their different densities. To distinguish between these two possibilities, we had already started an experiment to determine the absorption of the radiation under ice, which, although having a density approximately a thousand times that of air, has nearly the same atomic weight.

If we assume that the primaries have a cross-section for star-production proportional to the geometrical cross-section of the nucleus, we can calculate the expected ratio of the range in air to that in ice. Since the hydrogen in the ice is not disintegrated, the cross-section for star production depends only on the oxygen nuclei present. Hence we get

$$l_{air} : l_{ice} = 1 : 1{\cdot}16.$$

A calculation by George yields

$$l_{air} : l_{lead} = 1 : 2\,4,$$

which is in good agreement with the mean experimental ratio of $150 : 315 = 1 : 2\,1$.

On this hypothesis, we should expect a range in ice only slightly greater than that in air, whereas, if we suppose that the stars are produced by an unstable radiation, the absorption being proportional to mass, we find that the observed range in ice should be indistinguishable from that in lead.

Ilford *C*2 emulsions, 100 μ thick, coated on glass, were wrapped in black paper and packed in wax-coated cardboard boxes. These boxes were lowered, keeping the plates horizontal, into a narrow crevasse (about 10 cm. wide) in a glacier at the Jungfraujoch, height 3,650 m. Plates were thus exposed at the following depths below the surface of the ice for fifty days: 0 m., 1 m., 2 m., 3½ m. and 5½ m. By the end of the experiment the plates had been further covered by about 50 cm. of lightly packed snow. Taking an average value of 0·9 for the density of ice and allowing 5 gm./cm.^{2} for the snow coverage, we obtain the depths of exposure in gm./cm.^{2}. The experiment was commenced within one week of manufacture of the plates (four days were spent below 1,500 m., and three days below 200 ft. of rock at 3,650 m.) and the processing completed within four days of the termination of the experiment. We have not corrected our results for pre- or post-exposure.

Using a 4-mm. objective, the plates were scanned for stars at the rate of 1 sq. in. per day, and then re-scanned at half this speed. Using the results of both scannings, we are sure that not more than 1 per cent of the stars have been overlooked.

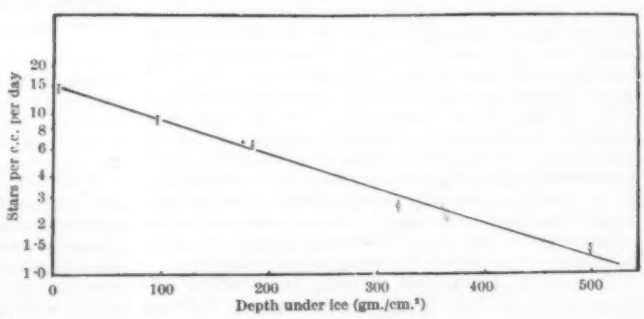
We have defined a star as having at least two prongs, one of which must have a range of more than 60 μ of emulsion, and we have only included those two-track stars which could definitely be distinguished from large-angle deflexions in single tracks. We have thus under-estimated the true number of two-track stars, but have included the certain ones in order to better our statistics. A significantly different result is not obtained by considering only stars with three or more prongs.

The number of stars per c.c. per day has been plotted on a logarithmic scale against the depth in gm./cm.^{2} of ice. The deviations shown are the calculated probable errors on the finite number of stars obtained.

Depth under ice in gm./cm.^{2}	5	95	185	320	500
No. of stars observed	138	102	91	84	78
Area of plates in cm.^{2}	19	22	29	64	110
Stars/c.c./day	14·3±0·8	9·1±0·6	6·3±0·4	2·6±0·2	1·4±0·1

The range of the star-producing radiation as calculated from the slope of the graph is 200 gm./cm.^{2}, which is 1·33 times the mean range (150 gm./cm.^{2}) in air. This is in fair agreement with the ratio calculated, assuming that the cross-section for star production is proportional to the geometric cross-section of the nucleus; and from the range of 200 gm./cm.^{2} we calculate an effective cross-section of 0·15 barns for an oxygen nucleus.

We thus conclude that the stars are produced by stable particles, their range depending on the atomic weight of the absorber. It may here be noted that



the radiation responsible for the single tracks has a range of 200 gm./cm.² in ice, thus confirming Perkins's earlier conclusions that the stars and single tracks are in equilibrium. This work is being reported fully elsewhere[3].

We should like to express our indebtedness to Prof. A. von Muralt and Dr. R. Stämpfli for providing facilities at the Jungfraujoch Scientific Station during the course of this experiment.

J. B. Harding
S. Lattimore
T. T. Li
D. H. Perkins

Department of Physics,
Imperial College,
London, S.W.7.
Jan. 12.

[1] George, E. P., *Nature*, **162**, 333 (1948).
[2] Perkins, D. H., *Nature*, **160**, 707 (1947).
[3] Lattimore, S., *Phil. Mag.* (in the press).

Adenosine Triphosphate and Muscular Contraction

It is commonly stated, on evidence obtained with muscle extracts, that the energy of muscular contraction is derived in the first instance from the breaking of the terminal energy-rich phosphate bond of adenosine triphosphate. Why not try to find out whether it really is, not in muscle extracts which cannot contract but in muscles which can?

The total energy obtainable from this source, from the whole of the adenosine triphosphate present in muscle, is calculated to be about 0·05 calorie per gm. In the maximal contraction of a frog's muscle at 20° C., this would last only about 0·5 sec. Before then, however, according to current hypothesis, the restoration of the adenosine triphosphate at the expense of the energy of creatine phosphate breakdown (the 'Lohmann reaction') is well under way; the difficulty of resolving chemical events occurring so rapidly might very well be regarded as insuperable. But there are two easy ways around this obstacle: (i) to use a slower muscle; and (ii) to work at a lower temperature. The liberation of energy in toad's muscle during maintained contraction is only half as rapid as in frog's, in tortoise's only 1/10 to 1/20 as rapid; and its rate can be diminished about nine times by lowering the temperature to 0° C.

One cannot be sure how fast the adenosine triphosphate (if it *is* broken down in contraction) would be restored by the Lohmann reaction at 0° C. during maintained activity. Apart from such restoration, its breakdown in toad's muscle would be complete in 10 sec., in tortoise's in 50–100 sec. Probably in times of this order a balance would be reached between breakdown and restoration, at a level substantially different from that at rest. The slowness of the processes involved, particularly in tortoise's muscle at 0° C., should allow ample time for the necessary treatment preliminary to chemical analysis, and good resolution in time could probably be obtained. The experiment might allow a clear decision to be reached as to whether adenosine triphosphate is really concerned with the contractile process as such, or whether —like every other chemical change known to occur in muscle—it is part of the mechanism of recovery.

Prof. T. B. L. Webster recently provided an epigram to be posted in my laboratory: Ὑπόθεσις ἔλεγχους μὴ ἀποδεχομένη οὐκ ἐξοιστέα, which means that hypotheses should not be put forward that do not admit of test. The hypothesis that adenosine triphosphate breaks down during the contraction of a living muscle ought not to be left in that category, but only biochemists can remove it.

A. V. Hill

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Jan. 10.

Meson Masses and the Principle of Reciprocity

In two previous letters, M. Born and H. S. Green have proposed a new theory of elementary particles and quantized fields and applied it to the case of mesons. We shall give some numerical results which follow from the theory.

There is an infinite number of particles predicted by this theory, the rest-masses of which are the square roots of the solutions of certain transcendental equations, namely,

$$\mathbf{L}_n^{(1)}(x) = 0, \tag{1}$$

where $\mathbf{L}_n^{(1)}(x)$ are the Laguerre polynomials of the first kind. The first of these were given in the first paper, and it is easy to calculate the following ones with the help of a well-known recurrence formula. We have solved the equations (1) and found the following values for their roots:

n	x				
1	2				
2	1·26	4·73			
3	0·93	3·31	7·75		
4	0·74	2·57	5·73	10·9	
5	0·53	2·11	4·61	8·40	14·26

These figures are connected with the masses in the following way: let a and b be the absolute length and momentum such that $ab = \hbar$. Then the wave equation for particles belonging to a given value x is

$$(p^2 - E^2 - xb^2)\,\psi = 0. \tag{2}$$

Hence one has for the mass

$$m = b\sqrt{x}/c. \tag{3}$$

Consider the first particle corresponding to $n = 1$ and replace b by $a/\hbar$, then

$$m = \hbar\sqrt{2}/ac. \tag{4}$$

Now we make the assumption which at the present state of the investigation cannot be justified from theoretical arguments but seems rather plausible, namely, that a is the classical radius of the electron, given by

$$a = e^2/\mu c^2, \tag{5}$$

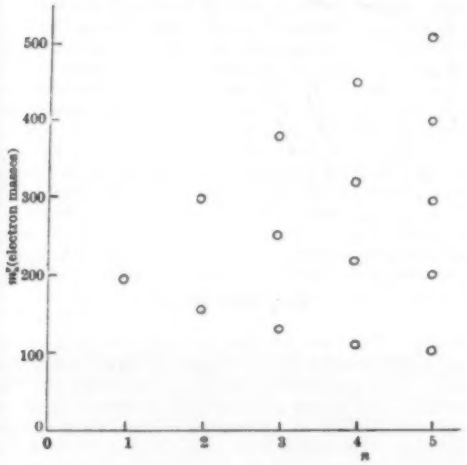
where μ is the mass of the electron. If this is substituted in (4) one obtains

$$\frac{m}{\mu} = \frac{\hbar c}{e^2}\sqrt{2} = 137 \,.\, \sqrt{2} \simeq 194. \tag{6}$$

We venture the suggestion that this value of m is the mass of the most stable meson. Indeed, the experimental determinations of the mass of the mesons which are observed at sea-level, and are therefore presumably the most stable ones, is given by the Bristol workers as about 200 μ, in good agreement with our calculated value. (According to the

report by J. A. Wheeler on the Pocono Conference, the value found at Berkeley is 192 μ.)

The accompanying figure gives the masses of the other mesons, based on the same assumption (5). One sees that the next most stable meson of higher mass has $m = 300\,\mu$, which corresponds very well to the observed π-mesons. The ratio of the two first calculated masses is 1·54, in good agreement with the results obtained in Bristol, while the Berkeley experiments are reported to give 1·32.



But there are many more less stable mesons predicted, and the spreading of the values obtained by different observers might be very well explained by the assumption that they had to do with different types of particles.

A preliminary investigation of particles with spin has shown that the rest-masses given by this theory are of the same order of magnitude except one, which is zero. Hence the observed small value of the mass of the electron must be of secondary origin, namely a self-energy produced by the surrounding electromagnetic field. Investigations of this question are in progress.

MAX BORN
ANTONIO E. RODRIGUEZ
Department of Mathematical Physics,
University of Edinburgh.
Nov. 9.

Optical Sensitization of Lead Sulphide Layers made without Oxygen

INFORMATION regarding the preparation of photosensitive lead sulphide layers has already been published[1,2], the preparation involving the introduction of oxygen as an essential impurity. Sensitive layers have now been made without the use of oxygen by forming the lead sulphide layer by evaporation in sulphur vapour.

During the course of this work, it was found that if the layer was collected on a surface at a temperature of about 100° C., it was not normally photosensitive, but could be made so by prolonged illumination by visible light of high intensity, while the cell was maintained at a low temperature (90° K.). The

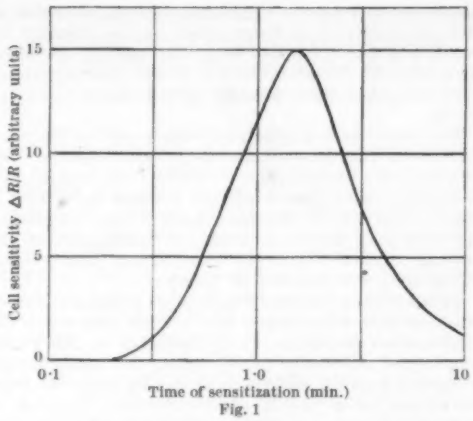


Fig. 1

photosensitivity (defined as the decrease, $\Delta R/R$, in cell resistance for unit incident intensity) was measured at a wave-length of 1·2 μ, using radiation of intensity small compared with that of the sensitizing light, which was shut off while measurements were being made.

The variation in cell sensitivity and dark conductivity during sensitization are shown in the figure, the time-scale being logarithmic. If at any time the sensitizing light is removed and the cell maintained at 90° K. in the dark, it returns slowly to its original condition. This process takes many hours at 90° K., but may be accelerated by warming slightly, suggesting that thermally metastable levels (that is, electron traps) are filled during sensitization. Sensitization at 77° K. proceeds more quickly than at 90° K., the subsequent decay proceeding more slowly, thus confirming the above hypothesis. Measurement of the thermal decay of the traps indicates that they have a depth[4] of about 0·3 eV.

The time taken to reach maximum sensitivity or a chosen value of the dark conductivity is inversely proportional to the sensitizing intensity, provided that this time is short compared with the mean decay time of the traps. The sensitivity and dark conductivity are thus a function of the product (sensitizing intensity × time), and it is found that the conductivity is described by the equation :

$$\sigma = \sigma_0 + c \log (I.t + 1),$$

where I is the sensitizing intensity in arbitrary units.

An equation of this type describes the number of electron traps filled on illumination of silver halide crystals[3] and zinc sulphide phosphors[4]. It seems

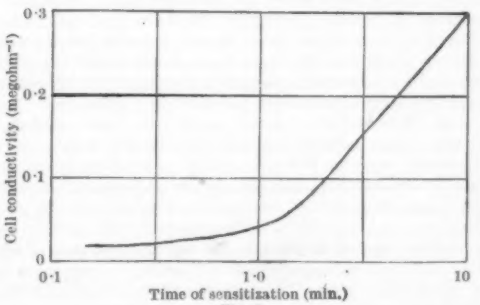


Fig. 2

reasonable to suppose, therefore, that the increase in dark conductivity is determined by the number of mobile positive holes left when the excited electrons are trapped. Thermo-electric power measurements confirmed that the conductivity was due to positive holes.

The sensitization spectrum was found to be very similar to the photoconductivity spectrum of free sulphur. In view of the conditions of preparation, it is likely that specks of free sulphur exist in the layer; and hence the sensitization process entails the raising of electrons from the filled band of the sulphur crystals into the conduction band, from which they are afterwards trapped.

There is no completely satisfactory explanation of the rise and subsequent fall in cell sensitivity as sensitization proceeds. It is analogous to the variation in cell sensitivity found during the manufacture of normal lead sulphide cells as the layer moves from an excess to a deficit semiconductor[2]; but it is curious that the point of maximum sensitivity does not coincide with a point of maximum dark resistance. The time constant of the cell (defined as the time taken for a signal to decay to $1/e$ of its original value) also passes through a maximum at about the same time as maximum sensitivity is reached.

The spectral response of the cells moves to longer wave-lengths during sensitization, the spectral limit reaching about the value found for normal lead sulphide cells at 90° K. when maximum sensitivity is reached[5].

The above work was carried out in the laboratories of the Telecommunications Research Establishment, Great Malvern, and thanks are due to the Chief Scientist, Ministry of Supply, for permission to publish this note.

A. F. Gibson

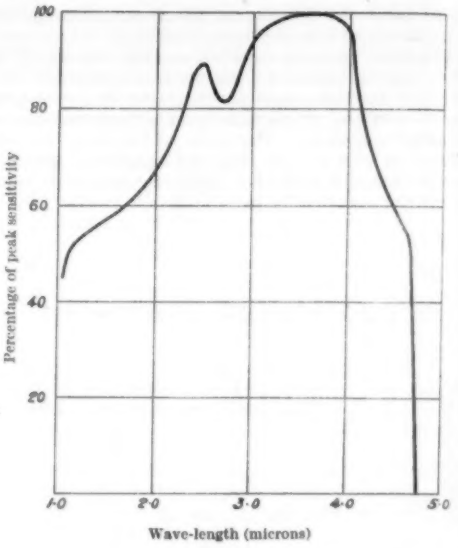
Physics Department,
Telecommunications Research Establishment,
Great Malvern, Worcs.
Sept. 24.

[1] Starkiewicz, Sosnowski and Simpson, *Nature*, **158**, 28 (1946).
[2] Starkiewicz, Sosnowski and Simpson, *Nature*, **159**, 818 (1947).
[3] Becker and Kippan, *Ann. Phys.*, (5F), **10**, 15 (1931).
[4] Garlick and Gibson, *Proc. Roy. Soc.*, A, **188**, 485 (1947).
[5] Moss, *Nature*, **159**, 476 (1947).
[6] Garlick and Gibson, *Proc. Phys. Soc.*, **60**, 574 (1948).

Lead Selenide Photoconductive Cells

The superiority of lead selenide photoconductive cells over lead sulphide cells and over purely thermal infra-red detectors in the 3–4 μ region has already been described[1,2]. The preparation of these sensitive layers has always been by an evaporation method[3,4] analogous to that previously used for lead sulphide[5]. Chemical deposition processes[6,7] for the preparation of lead sulphide cells have been further developed by us, until comparable sensitivity at room temperature and greater sensitivity at low temperatures than those obtained with evaporated cells are available.

We have recently made successful trials of a chemical process for preparing lead selenide layers, based on information about a process tried with unknown results by Sommer in Germany[8]. A thin film of lead sulphide is first deposited on the cell blank to act as a seed layer for the growth of the lead selenide microcrystals. This film is prepared by a short immersion in a bath of lead acetate and thiourea, while this is gradually made strongly alkaline. The lead selenide is then deposited on this seed layer from a bath of lead acetate and seleno-urea; this reaction is much slower than the lead sulphide deposition and usually requires about an hour to develop a sufficiently thick layer of lead selenide. The lead selenide film is then subjected to a partial oxidation by baking in air to about 300° C. for 10–15 min.



The sensitivity of these lead selenide cells when cooled with liquid air is such that a signal equal to noise is obtained for 10^{-8} to 5×10^{-9} watt/mm.^{2} of 200° C. black-body radiation, 800 c./s. interruption frequency with 30 c./s. band-width. A typical spectral distribution curve at liquid air temperature is shown in the accompanying graph. It will be observed that this type of lead selenide cell has a broad maximum at 3–4 μ, in this respect resembling the cells reported by Starkiewicz[4]. The position of the long-wave cut-off could not be exactly determined owing to the use of fused silica windows, which absorb strongly in the 4·5–5 μ region; good sensitivity, however, exists up to at least 4·6 μ.

These cells have so far only exhibited appreciable sensitivity at low temperatures, such as those of solid carbon dioxide and liquid air. The investigation is, however, still in an early stage, and these preliminary results are encouraging.

We desire to thank the directors of the British Thomson-Houston Co., Ltd., for permission to publish this note.

C. J. Milner
B. N. Watts

Research Laboratory,
British Thomson-Houston Co., Ltd.,
Rugby.
Aug. 26.

[1] Blackwell, D. E., Simpson, O., and Sutherland, G. B. B. M., *Nature*, **160**, 793 (1947).
[2] Moss, T. S., and Chasmar, R. P., *Nature*, **161**, 244 (1948).
[3] Simpson, O., *Nature*, **160**, 791 (1947).
[4] Starkiewicz, J., *J. Opt. Soc. Amer.*, **38**, 5, 481 (1948).
[5] Sosnowski, L., Starkiewicz, J., and Simpson, O., *Nature*, **159**, 818 (1947).
[6] B.I.O.S. Final Report No. 2, Item No. 9.
[7] Kicinski, F., *Chem. and Ind.*, **17**, 54 (1948).
[8] C.I.O.S. Item No. 9, File No. xxxiii-9.

Plastic Deformation of Optical Glass

I DESCRIBED recently a form of hardness micro-tester which permits light loads to be applied to a diamond indenter of pyramidal form as a means of determining the hardness figures of minute individual crystals in a mosaic[1]. It is also possible with the same instrument to draw the loaded indenter across a surface and to determine the hardness figure by means of a scratch test.

It was intended by this latter means to attempt to assess the hardness figures of many of the known types of optical glass, and a beginning was made in this direction. In addition, the opportunity presented itself of observing the form of the resulting fracture when the loaded indenter was used in a static manner and brought into contact with a plane polished glass surface. It was then discovered that a lightly loaded pyramid diamond left a perfectly defined and lasting impression on the polished surface. Thus, in the case of borosilicate crown and extra dense flint glasses, perfect impressions were formed with loadings up to about 50 gm.; with loadings of 100 gm., fractures appeared emanating generally from the corners of the square impression, and at some intermediate loadings fractures sometimes appeared after a short interval of time (Fig. 1).

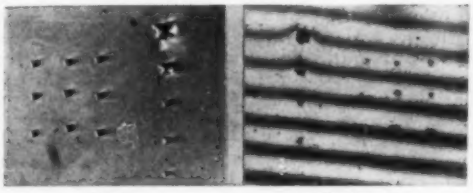


Fig. 1 Fig. 2

Fig. 1. Nine impressions under load of 20 gm. Single impressions under loads of 100, 50, 20, 10 and 5 gm. × 200

Fig. 2. As Fig. 1, but with the addition of interference fringes which indicate a raised rim around the two larger impressions. (Wave-length, 546 mμ.) × 200

With borosilicate crown glass 509/650, the diagonals of the impression under a load of 50 gm. measured about 12·3 μ, giving a hardness figure of 613; and under identical conditions the hardness figure for extra dense flint glass 650/337 was 433 with the diagonals measuring 14·6 μ.

The interesting fact is that the surface layer was found to be sufficiently plastic to take an impression. Thus, with a loading of 100 gm. the volume of the displaced borosilicate crown glass was 115 μ^3, and an interference test showed a raised rim of glass around the depression (Fig. 2). The volume of glass raised above the original surface was found to be about 90 μ^3, but accurate measurement was difficult and there may well be perfect correspondence.

In view of the uncertainty which exists regarding the nature of a worked glass surface[2,3], similar tests were carried out on a newly fractured and on a fire-polished surface of the same borosilicate crown glass. No difference in behaviour was noted and no evidence was forthcoming to support the presence of a soft superficial layer of glass on the optically worked specimen.

E. WILFRED TAYLOR

Cooke, Troughton and Simms, Ltd.,
Haxby Road, York. Nov. 5.

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A Theoretical Comparison of the Performance of Stationary-Target Crystallographic X-Ray Tubes Operating on Alternating and Direct Voltages

IT has been suggested that if a normally self-rectifying crystallographic X-ray tube is operated on D.C. instead of A.C., it should be possible approximately to double the power input to a tube and therefore similarly to increase the X-ray output. Unfortunately, this does not take into account the fact that the maximum target loading, determined by consideration of the heat dissipation, is normally obtained in a tube using A.C., so that at first sight it would seem to be impossible to increase the power input by operating the tube on D.C. However, as Terrill and Ulrey[1] point out, the temperature of the focal spot will fluctuate with each half-cycle in the case of A.C.; if the maximum temperature obtained is equal to the maximum permissible temperature for the target, which is also the steady temperature in the D.C. case, it follows that the average temperature will be lower for A.C. than for D.C. Thus the power input with A.C. must be made smaller than with D.C. in order that the maximum temperature shall not exceed the safe value. Terrill and Ulrey give no actual figures for this difference, but DeGraaf and Oosterkamp[2] state that with a four-valve circuit the maximum load is roughly 15 per cent higher than for A.C., and that for a well-smoothed 'Greinacher' voltage it is about 20 per cent higher.

It can be shown theoretically, moreover, that for a *given* power input the mean intensity of characteristic radiation is slightly greater for a D.C. high-voltage supply than for A.C., and so also, under certain conditions, is the ratio of intensities of characteristic and white radiations.

The relation[3] between the intensity I of the characteristic radiation, the current i passed by the tube, and the voltage V applied to it, is given by:

$$I = Ai\,(V - V_k)^{1.5};$$

where V_k is the critical voltage for the material of the anode, and A is a constant.

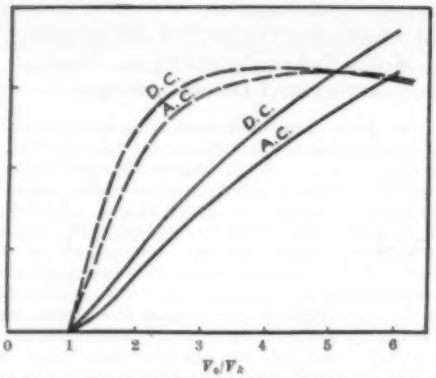
In the case of D.C., values of voltage and current can be substituted directly in this equation; but for the A.C. case it is necessary to obtain the mean value of this function over the whole voltage cycle, and this involves the integration:

$$I = A\,\frac{1}{\tau}\int_0^{\tau} i(V - V_k)^{1.5}\,dt,$$

where τ is the periodic time of the A.C. supply, and V is the instantaneous voltage at any point in the cycle. This integration has been carried out numerically, including only that part of the cycle where $V > V_k$.

The accompanying figure shows the variation of the intensity I with voltage V_e for both A.C. and D.C., the mean target loading, that is, the power input, being the same in both cases. In the A.C. case, V_e represents peak voltage, and it has been assumed that the voltage wave-form is purely sinusoidal; in the D.C. case, V_e has the same value as V.

The curves have only been drawn to values of $V_e/V_k = 6$, as at higher voltages it has been shown



Full lines, variation of intensity; broken lines, variation of contrast

practically that the intensity approaches asymptotically a limiting value[4].

Another important factor in crystallography is the ratio of the intensities of the characteristic and white radiations, which we might designate as contrast. The white radiation intensity[5] is proportional to iV^2, and hence for the D.C. case, a measure of contrast (C) is given by:

$$C = A(V - V_k)^{1\cdot5}/A'V^2.$$

In the case of A.C., integration is again necessary, the relation being:

$$C = A \int_0^T i(V - V_k)^{1\cdot5}\,dt/A' \int_0^T iV^2\,dt.$$

The variation of contrast with voltage for the two cases is also shown in the figure. It will be seen that the contrast curves each show a definite maximum, occurring when V_0 is equal to $4V_k$ for D.C. and $5V_k$ for A.C., the former being about 1½ per cent higher than the latter. Thus if the high-tension voltage is increased above these values, although there may be a slight increase in intensity there is a slight decrease in contrast. This explains the use of a voltage of about $5V_k$ to obtain the best results with the typical crystallographic X-ray set, the desired intensity being obtained by varying the emission current. This has no effect on the contrast, since both line and background intensities are affected to the same degree by altering the current.

The intensity curves show that, for a constant power input, and working at the usual voltage of $5V_k$, the theoretical increase in intensity obtained by using D.C. is about 18 per cent. This, combined with the possibility of a 20 per cent increase in the power input using D.C., results in a total increase in intensity of approximately 40 per cent.

It is therefore concluded that the increase in intensity obtained by operating a stationary target X-ray tube on a D.C. high-tension supply as opposed to an A.C. supply, although advantageous in itself, is considerably outweighed by the additional expense and maintenance of a D.C. supply. The ratio of characteristic radiation to white radiation, referred to here as contrast, is practically unchanged.

We thank Sir Arthur Fleming, director of research and education, and Mr. B. G. Churcher, manager of the Research Department, Metropolitan-Vickers Electrical Co., Ltd., for permission to publish this note.

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Metallic Delay Lenses

An experimental study of the metallic delay lens described by Kock[1] has been made in this Establishment, using a lens constructed of parallel strips as in Fig. 1, the E vector being normal to the line of the strips. The dimensions were such that Kock's formula for refractive index

$$n = \sqrt{1 + \frac{\pi}{4} s^2 N},$$

where s is width of strips and N is number of strips per unit area viewed end on, gave the value 1·41 for n. The predicted cut-off wave-length was 1·8 cm.

An experimental investigation of the optics of the lens gave a refractive index of 1·71 at $\lambda = 10{\cdot}0$ cm. The same degree of accuracy could not be achieved with $\lambda = 6{\cdot}0$ cm., but there was no measurable difference in the value of n. For $\lambda = 3{\cdot}0$ cm. the lens was practically opaque.

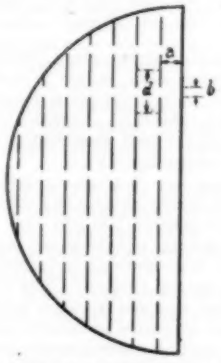

Fig. 1. Metallic delay lens

A new formula for refractive index has been calculated on the assumption that the refracting medium behaves similarly to a transmission line the characteristic impedance of which is that of air loaded at equal intervals by a capacitance, which depends on the width of the metal strips and the gap between them. The method of calculation is similar to those employed by Macfarlane and others in the study of wave-guides[2]. The computed values of refractive index are shown in Fig. 2, the cut-off wave-length being $\lambda = 2{\cdot}97$ cm.

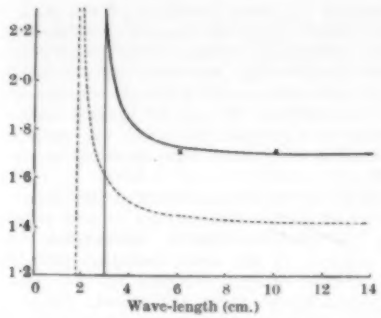

Fig. 2. Refractive index of metallic delay lens. ×—×—, observed points; full line, new formula; broken line, Kock's formula. Two vertical lines, broken and full, show cut-off at $\lambda = 1{\cdot}8$ and 2·97 cm., respectively

Over the range of wave-lengths for which the refractive index is constant, its value is given by:

$$n^2 = 1 + \frac{2d}{\pi a} \log_e \left(\operatorname{cosec} \frac{\pi b}{2d}\right),$$

where the distances a, b, d are as shown in Fig. 1.

The new formula predicts a value of n which is observed within experimental accuracy, whereas the formula given by Kock gave a value 18 per cent too low.

It is hoped to publish a fuller account of this work elsewhere.

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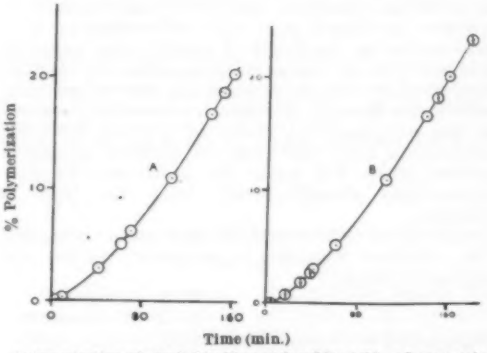
A New Catalytic Effect in Vinyl Polymerizations

In his experiments on the polymerization of vinyl chloride catalysed by benzoyl peroxide, Prat[1] observed that the rate of polymerization increased throughout the first 40 per cent of reaction. This acceleration he suggested might be either due to the gradual attainment of a steady state, consequent upon the existence of long-lived radicals, as suggested by Dostal and Mark[2], or alternatively to consecutive initiation reactions, as put forward by Cuthbertson, Gee and Rideal[3] to interpret a similar phenomenon in the case of vinyl acetate. This phenomenon in the case of vinyl acetate was later shown[4] to have been caused by the presence of impurities in the monomer.

Now the polymer which separates from liquid monomeric vinyl chloride is insoluble in the monomer. It is, therefore, possible to use a sealed dilatometer to give an accurate measure of the rate of polymerization. Such dilatometers containing accurately measured quantities of the benzoyl peroxide catalyst were filled with highly purified monomer by distillation in a high-vacuum apparatus, and sealed off. The results of Prat were confirmed: if the monomer had been insufficiently purified there was an induction period of up to several hours depending on the amount of catalyst added, during which absolutely no reaction could be observed, followed by a period of acceleration lasting for the first 40 per cent of reaction. Repeated purification (in particular from acetylene) reduced and finally removed completely the period of induction, but had no effect on the period of acceleration or the rate of the reaction.

In order to prove that this acceleration of the reaction in the case of vinyl chloride is a true kinetic effect and independent of impurities which are removed as the reaction proceeds, the following experiment was devised. Some purified vinyl chloride was polymerized to an extent of about 20 per cent conversion, in the presence of 1·04 mol. per cent benzoyl peroxide at 47° C.; the unchanged monomer was then distilled under vacuum into a second dilatometer which contained an amount of benzoyl peroxide such that its concentration in the new solution was equal to that in the original; the polymerization in the second dilatometer was then followed at 47° C.



Polymerization of vinyl chloride, catalysed by 1·04 mol. per cent benzoyl peroxide at 47° C. ⊙, original monomer; ①, unchanged monomer

In the accompanying graph, curve A represents the course of the first polymerization, and curve B that of the unchanged monomer. It is seen, on plotting the results from curve A on curve B, that both polymerizations proceed in an identical manner. It was then found that if vinyl chloride is polymerized to about 20 per cent polymerization, the unchanged monomer removed, and an equal quantity of fresh monomer added, the continued polymerization proceeds at the accelerated rate. This evidence makes clear that the phenomenon of acceleration is not caused by impurities which retard the rate initially, and indicates the conclusion that the polymerization is in some way catalysed by the precipitated polymer.

In confirmation of this, we have found that when polyvinyl chloride is added to vinyl chloride containing 0·5 mol. per cent benzoyl peroxide, and the mixture polymerized at 47° C., the rate of polymerization increases with the amount of polymer added; but in the absence of benzoyl peroxide no polymerization is observed even when large amounts of polyvinyl chloride are added. Further, if a solvent for the polymer, such as dibutylphthalate or tetrahydrofuran, is added to vinyl chloride catalysed by benzoyl peroxide at 47° C., the polymerization proceeds in the homogeneous phase at a constant rate throughout the early stages of the reaction, without any indication of the acceleration observed when the polymer is precipitated.

The conditions for polyvinyl chloride to exert a catalytic effect are therefore: (*a*) that it is present in an undissolved state; and (*b*) that benzoyl peroxide, or some other source of reactive free radicals, is also present in the system. It is suggested that this co-catalytic effect is due to a gradual increase in the total number of active centres as the polymer accumulates in the system. The additional centres are believed to be derived by a chain transfer reaction between free radicals and conglomerates of polymer, thus producing immobile radicals in the surface of the polymer which are largely free from the process of self-neutralization which occurs in the liquid phase. The number of these radicals will be proportional to the surface area of the polymer and also to the number of mobile radicals present, while the latter will depend upon the concentration of the catalyst. As the reaction proceeds there will therefore be an increase in the number of radicals present and consequently an increase in reaction-rate.

It is well known that 'polymer begets polymer'. For example, with vinyl chloride it has been found in technical operation that if a small amount of polymer be formed at a bend or constriction of a pipe conveying the liquid monomer under pressure, this will grow in course of time, often with serious results. Upon the above ideas it is easy to see that, even in the absence of catalyst, adventitious centres in the monomer can react, by transfer with the polymer as they flow past, to produce an active surface, which will cause the initial seed to grow continuously though slowly until the pipe is blocked.

A detailed kinetic analysis has been made, and this, together with full experimental results, will appear elsewhere.

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Photo-chemical Activity of Paint Pigments

Recent experience has shown that certain grades of zinc oxide of local manufacture markedly accelerated the initiation of chalking in paint films. In the course of an investigation into these differences, it was observed that they corresponded to differences in the fluorescent behaviour of the zinc oxides when irradiated with ultra-violet light. The zinc oxides (Series *A*, three samples from two manufacturers), prepared by burning zinc vapour in air (French process), showed no visible fluorescence at room temperature and markedly accelerated the initiation of chalking, as compared to the zinc oxides (Series *B*, four grades from three manufacturers) prepared by burning zinc vapour in air containing reducing gases (as in the American process), which showed a strong yellow fluorescence.

This result is in apparent conflict with some statements made in the literature[1], but a comparative test for fluorescence using an 'Osira' lamp has provided a useful means of selecting non-chalking grades of zinc oxide available in Australia.

A distinct difference in the photo-chemical activities of (*A*) and (*B*) was also noted. An aqueous suspension of (*A*), after irradiation for a short period with an 'Osira' lamp, was found to contain hydrogen peroxide[2], liberating iodine from potassium iodide solution, decolorizing permanganate solution and giving a yellow colour with titanium sulphate solution. Longer irradiation by direct sunlight also caused formation of hydrogen peroxide. A suspension of (*B*) treated in the same way gave no reaction for peroxide.

The major contributing factor in the different performances of paints containing (*A*) and paints containing (*B*) must be that in the former the high-energy portion of the solar radiation is utilized as photo-chemical energy, whereas in the latter it is dissipated as lower-energy radiation[3]. From (*A*) the energy may be transferred directly to the unsaturated fatty oil, providing the energy required for the removal of hydrogen from the α-methylenic group, this being the initial step of the oxidation suggested by Farmer[4]. From the above evidence, however, it appears to be more likely that transfer of energy to oxygen takes place followed by entrance of molecular oxygen at the double bond, as suggested by Hilditch[5]. The production of hydrogen peroxide in the presence of water also provides an explanation for the observed acceleration of chalking under moist conditions.

It is hoped that a detailed study of the fluorescence spectra and their dependence on environment for a number of differently prepared zinc oxides and other pigments will provide further information about their influence on the photo-chemical oxidation of paint vehicles.

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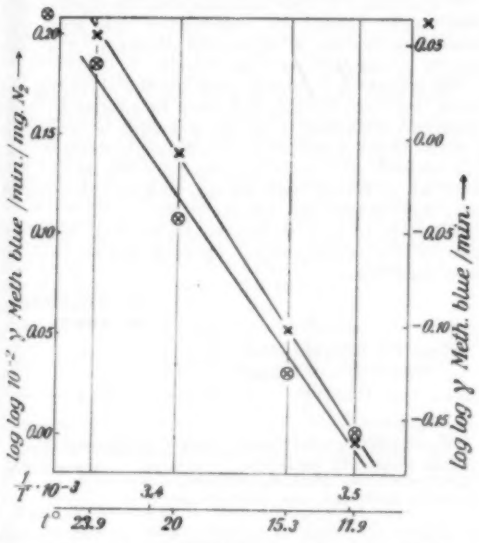
Thermal Activation of the Dehydrogenase Systems of the Unfertilized and Fertilized Eggs of the Sea Urchin, *Paracentrotus lividus*

Runnström[1] and Örström[2] were the first to try to compare the dehydrogenase activity in the sea urchin egg (*Paracentrotus lividus*) before and after fertilization by means of methylene blue reduction experiments. They could not reveal any difference. However, Ballantine[3], carrying out similar experiments, was able to demonstrate a rise in the rate of methylene blue reduction in the sea urchin *Arbacia punctulata* ranging from 2·2 to 3·7 times. In 1939 Miss Inger Stordal, in preliminary experiments in collaboration with one of us (P. E. L.), proved the methylene blue reduction by fertilized eggs to have a higher temperature coefficient than that of the unfertilized egg. The completion of these experiments was postponed because of the outbreak of war.

Our experiments carried out at Roscoff (France), at a temperature of about 12°, 16°, 20° and 24° C., confirm this result; thus the difference in reduction-rate is nil, or comparatively small, at 12°, but rather considerable at 24° C. This is due to the different slopes of the temperature curves, and also to the different forms of the curves, those of the fertilized

eggs being more bent than those of the unfertilized ones. Further analyses of these data reveal that, for the unfertilized eggs, the logarithm of the reduction-rate plotted against $1/T$ forms a straight line; but for fertilized eggs there is still a bent curve. If, however, the logarithm of the reduction-rate of the fertilized eggs once iterated is plotted against $1/T$, an approximately straight line is obtained (see graph). Thus the thermal activation seems to follow the Arrhenius equation in the unfertilized egg, whereas a more complicated relationship holds for the fertilized egg.



The rate of methylene blue reduction is referred to 1 mgm. of egg nitrogen (except in the experiments with egg extract). ⊕, fertilized eggs; ×, egg extract + coenzyme I + glucose-6-phosphate

It is well known from Warburg[4], Runnström[5] and others that the respiration of unfertilized sea urchin eggs slowly rises, this process being suppressed by agents inhibiting the respiration[5]. As in the experiments described, the unfertilized eggs were handled for about two hours before the performance of the measurement; during washing and mechanical removal of the jelly coats, their respiratory state was supposed not to correspond to the original one typical of the egg as expelled from the ovaries. Thus the ovaries were allowed to discharge into sea-water of 10° C., at which temperature the eggs were kept during the preparations. In such cooled unfertilized eggs the thermal activation is of still another type, the rate of methylene blue reduction giving a straight line when plotted against $1/T$.

We have thus observed three different types of thermal activation of the dehydrogenase activity in eggs: (1) that of the cooled, unfertilized eggs, representing the state of those freshly laid; (2) that of the uncooled eggs, representing the state after some hours in sea water; (3) that of the fertilized egg.

The difference in thermal activation of the fertilized and the unfertilized (cooled) eggs disappears when the eggs are crushed by adding distilled water, the same type of curve being obtained as in the case of cooled unfertilized eggs. We are unable to suggest any theoretical explanation for this type of curve. When, however, coenzyme I and glucose-6-phosphate are added to an almost clear egg extract, obtained by centrifuging crushed eggs, the very high rate of methylene blue reduction resulting shows a thermal activation identical with that of the fertilized living egg (see graph).

The dependence of the rate of the methylene blue reduction in an exponential way on the rate of another reaction, for example, a phosphorylation—the thermal activation of which follows the Arrhenius equation—may possibly be the basis of this iterated logarithmic function. Such a coupling between oxido-reduction processes and phosphorylations is well known to exist, for example, during the exponential induction phase of artificial fermenting systems. According to Lindberg and Ernster[6], the oxidation of glucose in homogenized sea urchin eggs is coupled with the esterification of phosphate.

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Effect of Necrosin on Spontaneous Tumours in Swiss Mice

I HAVE demonstrated within the last decade the presence, in inflammatory exudates, of various substances with definite biochemical properties. These substances are at present relatively crude, and it is hoped they will be purified further. Analysis of the exudate reveals some substances, which appear to be polypeptide in some cases and proteins in others, capable of reproducing the same effect as the whole exudate. Blood serum fails to show the presence of these substances unless there is a concomitant inflammation. This would indicate that presumably these substances penetrate from the site of injury into the circulation, for in the early stage of an inflammation they are absent from the blood, whereas they can already be detected at the site of an acute inflammation[1].

One of these substances is concerned with the basic pattern of injury in inflammation. It is closely associated with the euglobulin fraction, particularly of acid exudates. I have given the term 'necrosin'[2] to this substance. Its introduction into normal tissue induces severe injury with all the signs of an acute inflammation. Other protein fractions of exudative material fail to produce a similar picture.

Necrosin is found in the euglobulin fraction of exudates, freed in turn of insoluble material in the presence of electrolytes. Ludford[3] and Duran-Reynals[4] have shown that dyes or proteins are localized into tumours. Duran-Reynals ascribes this localization to the greater permeability of capillary vessels in a tumour than is found in normal circumstances[4]. For this reason necrosin, as a substance associated with a protein fraction of exudates, was injected into about two hundred Swiss mice with spontaneous tumours. The tumour is a mammary one and it is very vascular. The subcutaneous injections of the

material were always made at a distance from the tumour. The amount of necrosin administered in the fluid state varied from an equivalent dose of 0·2 μgm. of necrosin to 1,748 μgm. of lyophilized necrosin. After one or several injections, the material induced hæmorrhagic or other forms of necrosis, such as a mucoid-like yellowish fluid, or rarely a caseous-like central necrosis, in the tumour. Hæmorrhagic necrosis was also found to occur in some of the metastatic foci of the lung. A certain amount of necrosis in these areas appeared as early as one hour after the administration of necrosin. This toxic substance concomitantly causes hepatic injury in the form of vacuolation of the cytoplasm of the liver cells. Sometimes one encounters various forms of leucocytic infiltration in the liver. Whether or not the hepatic injury is the cause of the death of the animal is not yet clear. At times, injury to the kidney is also seen in the form of foci of leucocytes. This and other factors are at present under investigation, for to date there is no evidence that the span of life is prolonged with necrosin treatment. Nevertheless, the effect is specific and does not occur with other protein fractions, such as the euglobulin of normal blood serum or with papain. Further work is being conducted with different strains of mice; methods are also being devised to counteract the toxic effect of necrosin on the liver.

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Para-Aminobenzoic Acid in Human Leukaemias

BICHEL[1], and later Zarafonetis and co-workers[2], recorded interesting data concerning the effect of *para*-aminobenzoic acid in leukæmias.

In an attempt to confirm Bichel's findings, we investigated the effect* of a single intravenous injection of *p*-aminobenzoic acid on patients with leukæmias, and on controls; we administered the sodium salt in 3–5 per cent solution. The intravenous infusions were given for 10–21 minutes. In each case the total amount was 5 gm. The *p*-aminobenzoic acid serum levels (maximum) ranged from 18 to 31 mgm. per cent.

We made nine trials in seven patients with leukæmias and six trials in six persons not suffering from this group of diseases. The patients tested could be grouped as follows according to clinical condition: three chronic myelocytic leukæmic myeloses, one subchronic promyelocytic–myelocytic leukæmic myelosis, one chronic subleukæmic lymphoid leukosis, one chronic aleukæmic lymphoid leukosis, and one acute paraleukoblastic form. The group free from leukæmia included one healthy individual, one with Hodgkin's disease, one with Vaquez–Osler disease, one with cirrhosis hepatis, one with Besnier–Boeck–Schaumann disease, and one case of rheumatic fever.

We found that all four patients with myelocytic leukæmia developed a fever response, with chill and shivering, which occurred between one and four hours after the injection had been given. The fever might exceed 39° C. (102° F.), and showed no close relationship to the *p*-aminobenzoic acid blood-level or to the speed of the infusion. The two patients with lymphoid leukæmias and the case of acute paraleukoblastic form did not show this reaction; nor did the non-leukæmic controls.

The total and differential leucocyte counts, and the cells of the spleen (the latter were examined in only two cases), did not show constant significant deviations. It was remarkable that in our leukæmic patients the renal elimination of *p*-aminobenzoic acid occurred in the same manner as we have described for healthy individuals.

Our evidence to date indicates that the phenomenon here noted cannot be obtained if the leucocyte-producing system is under the influence of a completely developed urethane effect[3].

We suggest a humoral basis for the shivering and fever, and conclude that it may be caused by some substance liberated from the leukæmic leucocytes as a result of the administration of *p*-aminobenzoic acid. To confirm this view, experiments are in progress with whole blood, with serum, and with leucocytes, etc., inoculated into guinea pigs.

We hope to publish the results of these tests, and also of the investigation reported above, in detail later elsewhere.

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Failure of Transmission of Motor and Sensory Nerve Impulses after Nerve Section

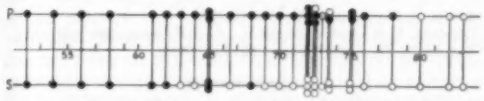
HITHERTO the time at which failure of transmission of nerve impulses occurs following section of the nerve trunk has been determined in mixed nerves only. In the popliteal and sciatic nerve of the cat it was found to occur after about three and four days respectively[1,2]. Erlanger and Schoepfle[3] found degeneration in the phrenic nerve to be complete after about four days.

It is possible that failure of impulse transmission after nerve section sets in at different times in different groups of nerve fibres. Indeed, Moenkeberg and Bethe[4] had shown histologically that degeneration proceeds more quickly in sensory than in motor nerve fibres, and von Muralt[5] as well as Rosenblueth and Dempsey[6] consider that the thick nerve fibres with a rapid conduction-rate degenerate earlier than the thin, slowly conducting ones. Rosenblueth and Dempsey found that in a few nerves the *A* spike had already considerably decreased at a time at which the *C* spike was still normal. They supported their conclusion also by the fact that the rate of conduction increased in the degenerating nerves when the stimulating electrode was moved peripherally towards the recording electrode, suggesting that degeneration followed a centrifugal course. However, Erlanger and Schoepfle showed that failure of nerve conduction does not proceed centrifugally, but that

conduction fails at scattered loci increasing in frequency peripherally.

We have re-investigated the question by using for comparison the sural and peroneal nerve of the rabbit. The sural nerve, apart from its sympathetic contribution, is a purely sensory nerve; the peroneal nerve, apart from its sympathetic contribution, contains afferent and efferent fibres from and to skeletal muscles. The nerves were excised at different times after section and placed in a thermostat on platinum electrodes. The temperature of the chamber varied from 36° to 38° C., but was approximately constant for any given set of observations. The electrical responses of the nerves were recorded by a cathode ray oscillograph (highest sensitivity 80 microvolts/cm.), the distance between stimulating and recording electrodes being 2–4 cm.

The time at which the nerves failed to conduct impulses after nerve section varied considerably in different animals, and was to some extent dependent on the age of the animal. Therefore the comparison was always made for the nerves of the same animal, and one- to two-year-old rabbits were used. From the accompanying diagram it will be seen that in the same animal impulse conduction failed about 10 hr. earlier in the sural than in the peroneal nerve. In the sural nerve, it failed after about 63–68 hr.; in the peroneal, after about 72–80 hr.



Times in hours at which the excitability of the peroneal (*P*) and the sural (*S*) nerves were tested following nerve section. Both nerves are taken from the same animal. Filled circles: action potential could be recorded; empty circles: no action potentials could be recorded when stimulating the nerve

Further evidence in favour of differences in the time course of degeneration in different groups of nerve fibres was provided by the electrical responses of the degenerating nerves. The height of the spike potential decreased with increasing time of degeneration. Moreover, in the sural nerve two spikes could be observed at the beginning, but one only at later stages of degeneration. The nerve fibres thus appear to cease functioning successively and according to a certain order.

We may conclude that the sensory fibres from the skin degenerate earlier than the afferent and efferent fibres in motor nerves. The thickness of the myelin sheath may be the main factor in determining the time course of degeneration after nerve section. These findings may be useful when classifying nerve fibres according to their morphological and physiological characteristics.

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Determination of Proteins in Cerebro-Spinal Fluid

It appears from conversations I have had with medical officers concerned with trypanosomiasis that there is a need for a reliable and rapid method of estimating the protein content of cerebro-spinal fluid. Existing methods that rely either on the estimation of opalescence or volume of precipitate[1,2], when a protein-precipitant is added to cerebro-spinal fluid, are open to a number of obvious objections.

I have found that the xanthoproteic reaction can be made quantitative and that an easily reproducible artificial standard can be used. The method is as follows:

Reagents. *M*/3 zinc sulphate solution; *N*/2 sodium hydroxide solution; 6 *N* nitric acid solution; 10 *N* sodium hydroxide solution. *Procedure.* Dilute 2·0 ml. of cerebro-spinal fluid with 4 ml. water in a centrifuge tube. Add 0·1 ml. *M*/3 zinc sulphate; mix. Add 0·1 ml. *N*/2 sodium hydroxide; mix and centrifuge. Decant the supernatant liquid and drain well. Add 3 ml. 6 *N* nitric acid and place the tube in boiling water for 15 min.; cool. Add 2 ml. 10 *N* sodium hydroxide. Cool and dilute to 6·0 ml. Compare the colour of the solution so produced with a suitable dilution of an accurately standardized solution of potassium dichromate.

The protein content of the cerebro-spinal fluid is given by: mgm. per cent of protein $= T/S \times C \times 1{\cdot}6$, when T/S is the ratio of colour intensity produced by the above method to that of the standard; C is concentration of standard dichromate solution in mgm. per cent of $K_2Cr_2O_7$.

The zinc hydroxide precipitate packs down well, even in a small hand-operated centrifuge, so that the method can be used in field stations. Alternatively, the zinc precipitate may be collected on a sintered-glass filter and afterwards washed through into a fresh tube with 3 ml. of hot 6 *N* nitric acid divided into small portions. 'Globulin' may be determined by adding to cerebro-spinal fluid an equal volume of saturated ammonium sulphate solution (adjusted to *p*H 5·4 with acetic acid) and separating the precipitate. The test may then be applied to this precipitate, giving 'globulin'. 'Albumin' can be calculated by difference from total protein.

The zinc hydroxide precipitation is only necessary when there is a possibility of the presence in the cerebro-spinal fluid of compounds, other than proteins, containing aromatic nuclei, for example, tryparsamide, sulphanilamide or similar drugs. If such compounds are known to be absent, the test may be applied directly by adding 1 ml. of concentrated nitric acid (s.g. 1·42) to 2·0 ml. of cerebro-spinal fluid and proceeding at once with the 15-min. heating in boiling water. The subsequent steps are the same as already described.

The dichromate solution is not of exactly the same colour shade as that produced in the test but is close enough to it to be almost indistinguishable in a Du Boscq or 'wedge' type of colorimeter when the protein in the cerebro-spinal fluid is less than 40 mgm. per cent, which is the most important range. A phenol solution may be used as a colour standard and gives a closer approximation to the shade of the test colour when put through the same process; but it was considered that for field use a hollow wedge colorimeter with dichromate solution in the wedge was the easier with which to work. It was interesting to note that when a Spekker photo-electric absorptiometer was used with Chance *OB*1 filters, the protein values obtained with the dichromate standard were only slightly greater (less than 5 per cent) than those determined visually in a colorimeter, using the same standard.

A micro-Kjeldahl method, adapted from a combination of the methods of King, Haslewood and Delory[3,4], and of Miller and Miller[5], was applied to individual samples of cerebro-spinal fluid and also to bulked samples. The figures for protein concentrations thus obtained were used to calibrate the dichromate standard. Unfortunately, owing to pressure of other work, it was not possible to devote as much time to this work as was desirable. The factor (1·6) relating dichromate colour to xanthoproteic colour cannot, therefore, be assumed to be absolutely accurate, but is not likely to be far wrong. In only a small proportion of the samples did the factor differ greatly from 1·6. This seems to justify the assumption that, although the colour developed in the test is dependent on the presence of phenyl groups in the protein, the proportion of these is substantially constant in the proteins of the cerebro-spinal fluids tested.

The factor 6·25 was used to convert the Kjeldahl nitrogen figures into protein figures. This assumption can only be checked by isolating and purifying the protein from cerebro-spinal fluid.

It is hoped to check and undertake a more detailed study of the method when an opportunity arises. However, as I can find no previous reference to a similar method, it appears desirable that these preliminary findings be made known so that other workers might be able to examine the method.

I wish to express my thanks to Dr. G. F. Saunders for indispensable help in obtaining samples of cerebro-spinal fluid and for his interest and constructive criticism, to Dr. G. Tooth for first bringing to my notice the need for a simple method of estimating proteins, and to Dr. J. G. S. Turner, director of Medical Services, Gold Coast, for permission to submit this note for publication.

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2 : 3 Dimercaptopropanol (B.A.L.) and Methyl Iodide Intoxication

Lewis[1] has reported the inhibition of SH enzymes by methyl bromide. It is therefore of interest to note that we have found a similar effect with methyl iodide.

Kerateine was prepared from sheep's wool by the method of Goddard and Michaelis[2]. A 0·2 per cent solution of kerateine in 0·1 *M* sodium carbonate was exposed to an atmosphere containing 10 mgm. of methyl iodide per litre, and a progressive decrease in the colour given with sodium nitroprusside was noted.

A suspension (0·5 per cent) of urease was made up (1) in distilled water, (2) in 0·98 *N* methyl iodide, and (3) in 0·98 *N* methyl alcohol/potassium iodide mixture. After standing four hours, 15 ml. of the urea/phosphate mixture of Sumner[3] was added to each. The mixtures were allowed to stand at room temperature, 21° C., and at intervals samples were withdrawn and ammonia determined with Nessler's reagent. An inhibition of about 50 per cent was found with the methyl iodide mixture, whereas the methyl alcohol/potassium iodide mixture was as active as the control, showing that the inhibition is due to the methyl iodide molecule as a whole.

Inhibition of urease by methyl iodide

Mixture	Ammonia (mgm./ml. reaction mixture)		
	At 20 min.	At 40 min.	At 60 min.
1	2·1	3·75	5·8
2	1·25	1·75	2·25
3	1·9	3·2	6·0

These results led us to try the effect of B.A.L. in methyl iodide poisoning in mice. A dose of 50 mgm. B.A.L. per kilo body-weight administered before exposure gives complete protection from a concentration which would otherwise be lethal for all the animals in a group; but B.A.L. given immediately after exposure has only slightly prolonged the time of survival.

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Estimation of Digestibility of Grazed Pasture from Fæces Nitrogen

In a recent communication in *Nature*, Raymond[1] has proposed a method of estimating the nitrogen content and the related nutritive value of pasture herbage consumed by grazing sheep from the nitrogen content of the resulting fæces. While this relationship should prove very useful in sheep nutrition studies, it appears likely, on the basis of work carried out at this Station[2,3], that a still more precise expression of the nutritive value of the herbage can be obtained from the data used by Raymond. It is the purpose of this communication to describe how the organic matter digestibility of pasture can be calculated from the nitrogen content of the fæces.

As a result of an analysis of the data from digestibility trials carried out at widely dispersed centres in New Zealand, a hypothesis was set up to the effect that the nitrogen excreted in sheep fæces per unit intake of pasture organic matter is constant. Knowing the value of this constant (C), and the concentration of nitrogen in the ash-free fæces (n per cent), the amount of organic matter in the herbage giving rise to 100 gm. of fæces organic matter will then be $100n/C$ and the digestibility will be given by

$$D = \left[\frac{\frac{100n}{C} - 100}{\frac{100n}{C}}\right] \times 100 = 100\left[1 - \frac{C}{n}\right]. \quad (1)$$

The value of C calculated from the data under analysis was 0·83 ± 0·102 gm. nitrogen per 100 gm. of pasture organic matter consumed. These data were collected from fifty-two digestibility trials covering pastures ranging in organic matter digestibility from 50 to 85 per cent and in protein content from 10 to 36 per cent (dry matter basis).

The accuracy of equation (1) for evaluating D is a function of n and of the standard deviation, s, of the constant C. Thus, if D and D_1 are calculated by using two values for the constant (C and C_1) differing by the standard deviation s, then

$$D = 100\left[1 - \frac{C}{n}\right], \quad D_1 = 100\left[1 - \frac{C_1}{n}\right],$$

and

$$D - D_1 = 100\left[\frac{C_1 - C}{n}\right] = \frac{100s}{n}. \qquad (2)$$

A convenient means of assessing the accuracy of the proposed method of estimating digestibility is provided by equation (2), which shows that the greatest accuracy is obtainable at the highest concentration of fæcal nitrogen. When equation (1) was applied to the data from the digestibility trials mentioned above, it was found to yield results for D the agreement of which with those calculated from measurements of feed ingested and fæces voided were well within the limits of accuracy predicted by equation (2), provided n was not less than 3 per cent (equivalent to about 15 per cent of protein in the pasture consumed). When n was less than 3 per cent, however, the accuracy was not as high as equation (2) predicted, and the results were biased in such a direction as to indicate that $C = 0{\cdot}83$ was too high a value for the low-protein pastures.

Mitchell[4], from an analysis of data from pasture digestibility trials with sheep, has shown that the small variations of protein excreted in fæces per 100 gm. of pasture dry matter consumed are positively correlated with the protein content of the pasture. This provides an explanation of the bias noted above, and suggests that greater accuracy could be achieved in the calculation of D if some provision could be made for the nitrogen content of the pastures. The number of trials on low-protein pasture, however, was considered too small to warrant an attempt being made to carry this out.

In view of these considerations, the investigation was extended to include as much material from published work as could be obtained locally. From the results of one hundred and one digestibility trials[5], plus the data from the fifty-two trials already discussed, a value for C was calculated. This proved to be $0{\cdot}76 \pm 0{\cdot}113$. The pastures covered in this investigation were located in England, United States, South Africa and New Zealand. They ranged in organic matter digestibility from 48 to 85 per cent and in protein content from 5 to 36 per cent.

Further inspection of the data indicated that they could be divided conveniently into two groups: (A), 103 trials, in which the protein content of the pasture was 15 per cent or more; (B), 50 trials, in which the protein content of the pasture was less than 15 per cent. On this basis, C was found to be $0{\cdot}80 \pm 0{\cdot}081$ for group A and $0{\cdot}67 \pm 0{\cdot}120$ for B.

The results of the foregoing discussion suggest that the method proposed of calculating the digestibility of pasture by sheep is of fairly wide applicability both in terms of pasture types and geographical location. The most important factor contributing to the different values of C obtained appears to be the nitrogen content of the pastures, and although the differences between these values are not statistically significant, real differences may nevertheless exist. Some advantages might, therefore, be gained by using values of C determined by the range of the nitrogen content to be expected in a pasture herbage under investigation.

From points made in this communication, the graph presented by Raymond may now be interpreted in terms of organic matter digestibility. Using $C = 0{\cdot}76$, the mean value obtained for all pastures studied, the nitrogen scale of his graph may be converted to a digestibility scale with a range from 69·6 to 81·0 per cent.

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A New Theory of Phyllotaxis

A REVIEW of my book "La Théorie des Hélices foliaires multiples", which appeared in *Nature* of November 20, p. 798, does not give an objective view of its subject-matter.

In my opinion, the fundamental character of a law being its generality, a common phyllotaxic law should at least apply to all the angiosperms. Now, the numerous phyllotaxic theories, all of which rely on the idea of divergence, cannot be verified except in particular cases or in ideal examples where the mind corrects and adjusts Nature where it is judged imperfect. The leaf considered as a point, or the stem considered as a cylinder, are typical examples of this idealization.

Taking as my starting point cases where it is impossible to find constant divergence along the line which, going from leaf to leaf, forms a genetic spiral—cases where it is only possible to trace a spiral because one wishes to do so and so makes corrections, with a pretence of metatopy, in the position of almost half the leaf points—I have discovered a law concerning the position of leaves on stems which has not previously been recognized. It is based on the existence of series of leaves called leaf-helices. The plotting of these lines is not arbitrary, since the successive leaves in a leaf-helix are contiguous so far as the segments by which they extend along the stem are concerned. The leaf-helices are usually two in the dicotyledons, but vary in number (frequently three, sometimes one) in the case of the monocotyledons.

This interpretation offers a solution to numerous problems of morphology. It unifies the arrangement of leaves in spirals or in whorls, and explains the frequent change from one to the other on the same plant. It unifies the most diverse leaf arrangements and explains the stems of palms as well as cacti. It offers a new explanation of teratological phenomena present in leaf-bearing stems, and, in particular, fasciation. It offers a hypothesis on the nature of the growing-point; but I have also shown that experiment alone can demonstrate the value of the theory.

It is not reasonable of the reviewer to reduce the book to a hypothesis on the physiological constituents of the growing-point. Moreover, the way in which he has substituted, in the title and the matter of his text, the idea of leaf formation for the idea of phyllo-

taxis—which implies only the arrangement of leaves on stems—in order to criticize the absence of studies on growing-points, betrays confusion on his part. Moreover, readers will find that the points of view of the reviewer have been met in an article called "Hélices foliaires, point végétatif et stèle chez les Dicotylédones" which appeared in the *Revue générale de Botanique* (**54**, 49; 1947).

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PROF. PLANTEFOL'S chief criticism of my review seems to be that I have taken as the most important feature of his book the conclusions concerning leaf formation at the apex which he has based on his observations of the relative positions of leaves or of their scars on mature stems. He claims that even apart from these conclusions his observations have value and lead to a law which solves various morphological problems. But his book and also his recent paper make it appear throughout that this law or theory, the theory of the foliar helices, was indeed intended as a causal theory of leaf formation. Thus, for example, on p. 195 of his book, in discussing *Lilium candidum*, he refers to the three foliar helices which he finds as being a "système fait de l'activité de trois centres générateurs de feuilles, entités douées chacune de propriétés mitotiques particulières, qui se transmettent de proche en proche suivant la ligne que trace l'hélice". I maintain, therefore, that I was right in regarding his theory of the foliar helices, supplemented by his theory of the apical organiser, as being essentially a causal theory of leaf formation at the apex, though based on observations made on mature parts of shoots. If he now proposes to regard this theory as being essentially only a descriptive rule, then how can such a descriptive rule concerning the positions of leaves on mature stems explain anything, or lead to anything more than a classification of facts?

My criticism of the theory that leaves are formed along the foliar helices was that these helices are at best only one set arbitrarily selected from the two well-known sets of intersecting parastichies, or paths along which the bases of leaves or other lateral members are in contact. Prof. Plantefol claims that his helices are not arbitrary, since the bases of the lateral members are in contact along them. But so also are they in contact along the helices or parastichies of the other set which crosses the first set, as can easily be seen on a pine cone, for example; and there are no valid grounds for preferring the one set to the other. The same can be seen in the figures of bud sections in his recent paper, in which he marks the parastichies of one set as being his foliar helices, but ignores those winding round the apex in the opposite direction. Also there is no rule that the parastichies of either set are only two in Dicotyledons, though the number two is rather common for the reasons given before. So the theory is another theory of leaf formation along lines continuing parastichies into the apex, something like that of Church[1], but with the disadvantage that it is based on an arbitrary selection of parastichies. In addition, all such theories are in conflict with evidence now available from experiments on stem apices[2] which reveal no *leaf-forming* influences extending into the stem apex from below or obliquely below, but only effects *delaying* leaf-formation which are exerted by the young leaves just below the apex. The only indications of leaf-forming influences from below are at present those obtained by Weisse[3] in various ridged succulents: and those influences do not follow the parastichies but the nearly vertical ridges.

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Threat of Disease in Tropical Crops

THE report by a committee of pathologists of three nations which has been inquiring into swollen shoot disease of cacao (His Majesty's Stationery Office, Colonial No. 236) contains matter of interest beyond the field of inquiry. Pathologists in the past have often been inclined to consider infection in a biological vacuum. The disease organism (assisted in the case of viruses by a vector) was regarded as an agent of destruction subject to no external conditions except those which might be imposed by pathologists.

This attitude has left its mark on the present report. It asserts that, "Drought, old age, lack of canopy, and poor soils have nothing whatsoever to do with it"—the disease. This is emphatic. But it is not a conclusion derived from experiments with swollen shoot of cacao. The genetically unstandardized condition of the cacao trees in West Africa would invalidate any experimental evidence that might be available on the question. None, in fact, is adduced by the committee.

In a word, there is no reason for supposing that the committee has discovered an exception to the biological law that external (as well as internal or genetic) conditions affect to a greater or less degree the incidence of every type of pest and disease of plants and animals.

On the other hand, the genetic variable is of the first importance, and this is recognized by the committee. It points out that "the development of varieties resistant to infection would be an ideal solution of the problem". But it omits this fundamental principle from its conclusions; and it has postponed the application by a dangerous misstatement: "It takes *many* years to obtain seed from a single crossing of two parents". In fact, it takes *two* years; and this time could be reduced by experimental improvement of growing conditions. Hence, the committee concludes, "This is a long term problem without any immediate practical significance". This is again emphatic. But what does it mean? It means that in prosperity plant breeding had no immediate significance. In disaster it has no practical significance. Thus in cocoa as in all other British tropical crops (except cotton) the ideal solution, the fundamental solution, has still to be treated as a subsidiary matter of no urgency. And there is no plan for attempting it. This is the immediate and practical significance of the report on swollen shoot in cacao.

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ROYAL SOCIETY OF CANADA

ANNUAL MEETING

THE 1948 meeting of the Royal Society of Canada was held at Vancouver (June 14–16) and Victoria (June 17) in British Columbia. This was the first time in its sixty-six years of existence that the Society has met west of Winnipeg, and for a while it seemed that the serious floods of the Thompson and Fraser Rivers would force the cancellation of the sessions here reported.

A general meeting of the Society, at which new fellows were introduced, was held on the morning of June 14. Those elected to the Scientific Sections of the Society were as follows: Section 3 (chemical, mathematical, and physical sciences), John David Babbitt, Adrien Cambron, Frank Thomas Davies, Richard Norman Jones, Robert Lloyd McIntosh and George Michael Volkoff; Section 4 (geological sciences), John Fletcher Caley, Edward Darwin Kindle and John Tuzo Wilson; Section 5 (biological sciences), James Kenneth Wallace Ferguson, F. E. J. Fry, Nathaniel Hew Grace, Rene Pomerleau, Frederick Smith and Omond McKillop Solandt.

On the evening of the same day the Flavelle Medal was presented to Margaret Newton, who was for a long time associated with the Dominion Rust Research Laboratories at Winnipeg, and whose work on the fungi attacking wheat has been of such importance in Canada. The Lorne Pierce Medal was awarded to Gabrielle Roy, author of "Bonheur d'Occasion", and the Tyrrell Medal to Canon Groulx. The president of the Society, Dean W. P. Thompson, of the University of Saskatchewan, then delivered his presidential address on "Mutations". This proved to be a masterly treatment of a difficult subject, made intelligible to a general audience. The final meetings were held in Victoria on June 17.

Officers for the session 1948–9 were elected as follows: *president*, Dr. Gustave Lanctot; *vice-president*, Dr. J. A. Pearce; *honorary secretaries*, Dr. F. J. Alcock and Dr. Seraphin Marion; *honorary treasurer*, Dr. L. E. Howlett; *honorary editor*, Dr. G. W. Brown.

Section 3: *President*, Dr. J. S. Foster; *vice-president*, Dr. C. S. Beals; *secretary*, Dr. H. G. Thode.

Section 4: *President*, Dr. Victor Dolmage; *vice-president*, Dr. T. L. Tanton; *secretary*, Dr. George Hanson.

Section 5: *president*, Dr. A. H. Hutchinson; *vice-president*, Dr. T. W. M. Cameron; *secretary*, Dr. R. D. Gibbs.

In Section 3 the presidential address, delivered by Dr. E. W. R. Steacie, was on "Photosensitization", an illuminating review of processes involved in photochemical reactions. Two symposia, of interest to the whole section, were held, at the first of which, on "Chemical Kinetics", four papers were presented: "Reactions of Atomic Sodium", by Dr. D. J. LeRoy; "Halogen-Sensitized Photoreactions", by J. W. T. Spinks; "The Thermal Decomposition of Complex Molecules", by C. C. Coffin; and "The Radiation Chemistry of Aqueous Solutions", by F. H. Krenz. LeRoy studied the subsequent reactions of the free radicals invariably produced in the primary reaction between atomic sodium and various halides. Particular attention was given to the free vinyl radicals produced in the reaction of atomic sodium with vinyl chloride and vinyl bromide. When using hydrogen as a carrier for atomic sodium, spurious results may sometimes arise. Reactions due to atomic hydrogen were possible in such a system as one containing sodium hydride, hydrogen and ethane. Spinks, using spectroscopic evidence which indicated whether absorption of light by the halogen results in the formation of atoms or excited molecules, together with kinetic studies, described the mechanisms of a number of photochemical reactions sensitized by chlorine, bromine and iodine. Coffin discussed the effect of molecular structure on the activation energies, frequency factors, etc., of certain decompositions, particularly those of methylidene diacetate, peraldehyde and their homologues decomposing in the gaseous state at temperatures low enough to ensure the absence of free radical complications. F. H. Krenz described work to determine the 'indirect effect' on biological systems of the hydrogen atoms and hydroxyl radicals produced in aqueous solutions subjected to radiation. The effect was studied through the properties of irradiated water. Evidence was obtained for the production of long-lived activity in irradiated water, which may be due to electronically excited 'polymers' of water, and which may account for the efficiency of the 'indirect effect'.

At the second symposium, on "Nuclear Physics", papers were presented as follows: "Experiments with Neutrons", by Dr. B. W. Sargent; "The $4n+1$ Radioactive Series", by E. P. Hincks; "Variations in Isotope Content of Light Elements", by H. G. Thode; "Progress Reports on McGill Cyclotron Project", by J. S. Foster; "Nuclear Physics Programme of the University of British Columbia", by G. M. Shrum. Sargent discussed determinations of the half-life of photoneutrons, measured after shutting down a low-powered atomic pile, following different lengths of activation. Instrumentation had to be improved to allow for the large range of intensity encountered. Thode described experiments using a mass spectrometer to measure the isotopic constitution of boron obtained from various mineral deposits in the earth's crust. This investigation involved the use of boron trifluoride gas prepared from boric acid. Both BF_2^+ and B^+ ions were considered in the determination of the boron-11/boron-10 ratios. Automatic recording equipment gave the relative values of these ratios for the different samples with a precision of $\pm$ 0·1 per cent and an absolute accuracy of $\pm$ 0·5 per cent or better. The ratio was found to vary from 4·27 to 4·42, depending on the source of the boron. Corresponding variations in the chemical atomic weights have been calculated using the latest mass data for the isotopes. For the remainder of the programme Section 3 was divided into subsections, and seven papers were given in the subsection on chemistry, twenty-eight papers in general physics and mathematics, and fifteen in astrophysics and geophysics.

In Section 4 the presidential address, delivered by Dr. F. J. Alcock, was on "Problems of New Brunswick Geology". The rocks of New Brunswick range in age from Precambrian to Triassic. Deformation and intrusion took place in the Precambrian, the Devonian and the Carboniferous ages; and the Triassic rocks have been extensively faulted. Volcanism was recurrent. Detailed study in local areas

has established the main facts of the geological story of the Province, but there are many places where the absence of fossils, the metamorphosed character of the rocks and the predominance of volcanic members present problems of correlation. The paper gives the conclusions reached by the author as a result of field work carried out in that region over the last quarter of a century, and is a most useful summary for all who are interested in the Appalachian geology of eastern Canada.

Thirteen papers were presented, and a lively discussion on the origin of granites followed the presentation of a paper entitled "Back to Logan" by H. C. Cooke, in which he briefly reviewed the development of theories of granitization and concluded, in harmony with an early interpretation by Sir William E. Logan, that many bodies in granite in Canada have been thus formed. Problems in the interpretation of age relationships of granites were dealt with in "Extent of Proterozoic Granite Intrusions in the Western Part of the Canadian Shield", by J. F. Henderson, and "The Relation of the Granite and the Seine Series at East Shoal Lake, Ontario", by E. L. Bruce and J. S. Ross. "Recent Data on the Nature and Origin of some Iron Deposits in the Canadian Shield", by E. S. Moore, gave information about Algoma and Labrador, where exploration for iron ore is in progress. "An Occurrence of Boron Minerals at Silver Harbor, Ontario", by T. L. Tanton and Eugene Poitevin, described a vein in which danburite has been found for the first time in Canada. "Radioactive Nodules in Sediments of the Sibley Series, Nipigon, Ontario", by T. L. Tanton, reported the results of a recent study of nodules in the red beds of the Sibley series, which were observed to be lithologically similar to uranium-bearing nodules in the Permian red beds of Devon, England. "Eoeponidella", by R. T. D. Wickenden, described a new genus of foraminifera. A paper of general interest to the members of the Section was "The Geological History of Greater Vancouver", by M. Y. Williams.

Section 5 had a very crowded programme with more than fifty papers listed, and for some sessions the Section split into separate botany, zoology and medical sciences subsections. The address of the president, Dr. E. Gordon Young, of Dalhousie University, was entitled "Canadian Dietary Patterns, 1937–1947", and constituted a survey of work on diets in Canada, particularly with reference to the war years. One session was devoted to a symposium on atomic energy in relation to biology. Contributors to this were an introduction by G. M. Shrum; "Problems of Handling and Measuring Stable Isotopes", by H. G. Thode; "Measurement and Handling of Radioactive Isotopes", by A. J. Ciprianni; "Precautions for Workers Using Radioactive Isotopes", by G. H. Guest; "Botanical Problems", by J. W. T. Spinks; and "Radiation Genetics", by C. E. Ford.

It was natural that sessions held in British Columbia would include several papers on salmon and other fish. "Mortality in Pink Salmon" was discussed by A. L. Pritchard; "Fecundity and Mortality in Pacific Salmon" and "Migrations and Spawning of Sockeye Smolt" by R. E. Foerster; and "Movement of Fundy (Atlantic) Salmon" by A. G. Huntsman. Papers dealing with the butter sole and the lemon sole were read by J. L. Keith Stuart Ketchen, and A. L. Tester spoke on "Catch Limitations for Regulation of the B.C. Herring Industry".

SOLUBILITY OF INDUSTRIAL SILICEOUS DUSTS

By Dr. P. F. HOLT
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AND
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THE theory that tissue damage in silicosis is caused by silicic acid formed by solvent action of the plasma on inhaled particles stimulated the study of the solubility of airborne siliceous dusts and of the materials which give rise to them. The investigation of the solubility of mineral silicates is complicated by their peculiar properties. When a powdered siliceous mineral is shaken with water, the solution may contain particles which range from large colloidal particles to simple ions; and different workers have determined the solute gravimetrically after filtration[1], gravimetrically after ultracentrifuging[2] or colorimetrically as the silicomolybdate complex which is formed both with simple and with more complex colloidal silicic acids. King and McGeorge[3] consider that the colorimetric method is most likely to give figures representing physiologically active 'soluble silica'.

A mineral suspension does not reach equilibrium with the liquid phase within a reasonably short time, and a comparison of the solubilities of two substances must normally be made by comparing the quantities of solute after a fixed time. The apparent solubility depends on the temperature, the particle size of the dust and on the ratio of dust to solvent[4]. Since the extraction of dust particles in the lung by constantly changing lymph is so complex a process that any true imitation is impossible, investigators have attempted to compare solubilities under simplified fixed conditions, and with simpler solvents. For example, Briscoe and others[4] investigated the effect of water, Whitehouse[5] used 1 per cent sodium carbonate solution, Emmons and Wilcox[6] used plasma, while King and McGeorge[3] used ascitic fluid, similar to plasma but with less protein.

Experiments already reported[4] have shown that airborne industrial flint dusts have a relatively high silica-solubility in water at 100° C., and this solubility increases greatly as the particle-size is reduced. Under the same conditions industrial cement dusts show a much smaller solubility which varies but little with particle-size. Since flint produces silicotic lesions and cement does not, these results were accepted as supporting the general theory that dangerous dusts have a higher solubility than those which have no pathological action. Further investigation has shown that the solubility values are widely influenced by a number of additional factors. For example, the proportion of silica which dissolves

Table 1. Solubility of flint dusts in water at 100° C.

	Dust : water ratio	Raw flint	Calcined flint
Composition of dust			
SiO_2	—	76·0	79·1
CaO	—	12·7	6·5
Composition of solute			
SiO_2 (mgm. from 1 gm. dust)	1 : 100	3·9	1·2
	1 : 1000	8	24
CaO (mgm. from 1 gm. dust)	1 : 1000	12	64

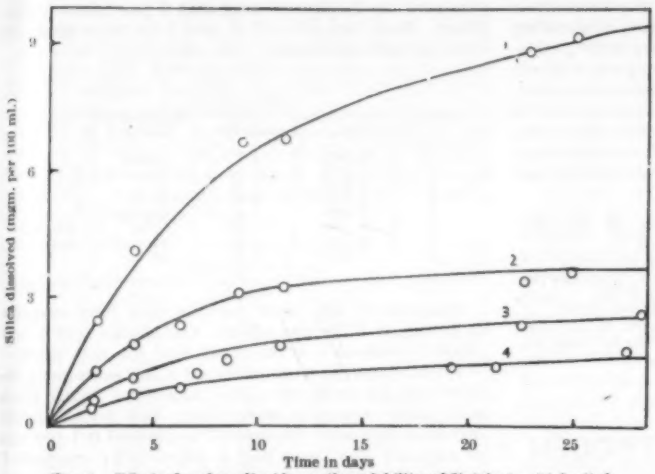

Fig. 1. Effect of carbon dioxide on the solubility of flint dust. (1) Ignited sample + CO_2; (2) normal sample + CO_2; (3) normal sample + air; (4) normal sample + air free from CO_2

from these industrial dusts depends markedly on the gravimetric ratio of dust to water, as is well illustrated by the figures for raw and calcined flint dusts given in Table 1.

Carbon dioxide will also affect considerably the solubility of dusts. Calcium is present mainly as carbonate in raw flint dust, and as carbonate, silicate and sulphate in calcined flint dust. The silica solubility figures shown by the dusts in the presence of carbon dioxide may be influenced by one or more of the following factors:

(*a*) Calcium silicate is decomposed by carbon dioxide, resulting in an increase in the silica which passes into solution, as is shown by re-igniting a sample of calcined flint dust, thus converting much of the calcium sulphate into calcium silicate. The solubility is much increased (Fig. 1).

(*b*) Carbon dioxide reduces the solubility of lime-free flint.

(*c*) Calcium carbonate increases the solubility of flint. The effects (*b*) and (*c*) were demonstrated by using calcined flint dust freed from calcium by washing with hot hydrochloric acid and water. Three 1-gm. portions of this sample were extracted with 100 ml. of water through which air, air freed from carbon dioxide, and carbon dioxide respectively were bubbled. The solubility values given after three days are compared in Table 2 with those obtained when the original flint dust was similarly extracted. It is apparent that, whereas the original dust is considerably more soluble in the presence of carbon dioxide than in its absence, the reverse is true of the acid-treated sample. Moreover, the solubility in the absence of carbon dioxide is much greater after acid extraction. King[7] found that the solubility of a number of dusts in Ringer solution was considerably increased after acid treatment. The addition of calcium carbonate, a substance which is present in most industrial dusts, to calcium-free flint dust increases its solubility to a maximum value in the presence of carbon dioxide; further addition lowers the solubility (Table 3).

Table 2

	SiO_2 (mgm.) dissolved from 1 gm. of dust		
	CO_2	Air	CO_2-free air
Acid-extracted dust	0·2	4·3	8·6
Untreated dust	2·0	0·9	0·6

The curves in Fig. 2 are plotted from data obtained by following the silica-solubility of calcined flint and cement dusts when extracted with water in the presence of carbon dioxide at 18° C. In both cases the water was replaced periodically. The rates of solution in the first and fourth extractions are illustrated. Flint shows a progressive decline in the rate of solution with each successive extraction, but the opposite is true for cement. Carbon dioxide increases the silica-solubility of cement to a value comparable with that of flint, and the value is increased in subsequent extractions until it is considerably higher than that of flint.

The experiments recorded indicate that solubility values can be greatly altered by variation in the conditions of extraction. Since the composition of the dust, particularly with respect to the form and concentration of the calcium compounds it contains, largely affects the solubility, a change in composition resulting from the removal of the more soluble constituents will alter the silica-solubility values during subsequent extractions. *In vivo*, the fluid affecting the particles is continually renewed, and possibly the solubility *in vivo* might be more nearly deduced from a study of the curves obtained by repeated extractions than from any single solubility

Table 3

$CaCO_3$ added (mgm. per 1 gm. flint)	Dissolved SiO_2 (mgm. per 100 ml.)
0	0·6
18	1·9
93	4·1
187	5·9
300	5·7
500	5·1
1000	4·3

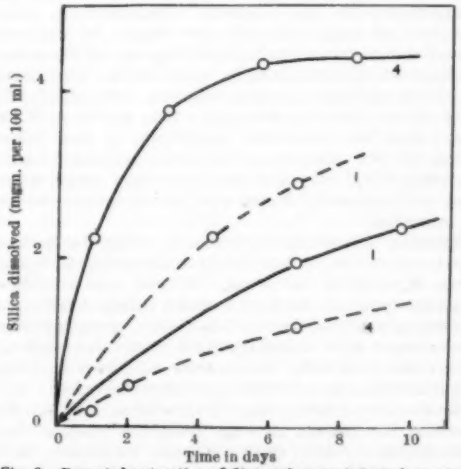

Fig. 2. Repeated extraction of flint and cement dusts by water saturated with carbon dioxide. Curves 1, first extractions: curves 4, fourth extractions.
——— Cement; - - - - flint

determination. Simple comparison of the solubilities of dusts using fixed conditions may give misleading results, and the correlation of solubility with pathological action by *in vitro* means will require a much more exhaustive study than has so far been attempted. In experiments designed to show the dissolution of dusts in the body, which will be reported elsewhere, cement has shown a relatively high solubility as compared with flint, sand (harmful dusts) and carborundum (harmless).

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FIXATION OF FREE NITROGEN BY BARK BEETLES

By Prof. J. PEKLO and J. SATAVA
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IN 1912 and 1916 one of us isolated *Azotobacter* (*A. Sulcii*) from Aphides[1,2]. More recently, L. Tóth and others[3] proved by micro-Kjeldahl determinations that species of *Rhynchota* (Aphides, etc.) can also rapidly and considerably increase their nitrogen content by utilizing atmospheric nitrogen, though Smith[4] has not been able to confirm these results. This year, we made more progress in studying nitrogen fixation by the bark beetle, *Ips*, which has done much damage lately in Czech spruce forests.

The larvæ were mostly collected in mountain forests. Over successive intervals they were crushed with oxalacetic acid solution or similar reagent, oven-dried at 100° C., and subjected to Kjeldahl estimations. Using large amounts (0·5–0·8 gm.), as described by Csaky and Tóth[5], did not give good results. Samples often showed a decrease in nitrogen compared with the controls. Hence, only small numbers of larvæ (30–50) were used. It was also found that results depended on the age of the larvæ. Half-grown (approximately three weeks old) larvæ fixed atmospheric nitrogen, whereas fully fed and fat ones often showed a decrease. This agrees with our view[6] that the microbial symbionts of *Ips*, which occur in the peripheral (so-called adipose) tissue, soon find their way into the alimentary canal, where they are digested. Pupæ and young beetles do not fix nitrogen.

Though they were often found under the bark in great quantities, it was found inadvisable to collect larvæ directly in the forest. It was best to collect large samples (10–15 kgm.) of the infested bark and to isolate the larvæ in the laboratory, grouping them according to size. Even so, it was sometimes difficult to ensure that only one species of *Ips* was under examination, since several can occur together.

In the first series, using *Ips amitinus* L., from the Jizerské Mountains, in July 1948, the reagent used was either: (*A*) 0·088 per cent oxalacetic acid, 0·5 per cent dextrose, 0·7 per cent sodium chloride, 5·4 per cent dipotassium hydrogen phosphate; or (*B*), which contained 0·2 per cent succinic acid in place of the oxalacetic acid and 9 per cent of phosphate. Both had pH = 7·2, and 3 c.c. were used with each sample of larvæ.

Sample	Dry weight (gm.)	Per cent N in dry material	Duration of fixation	Increase of N
1	0·2466	1·7	control	—
2	0·2480	1·92	13 hr.	13 per cent
3	0·2473	1·81	24 ,,	6 ,,
4	0·2552	2·08	48 ,,	21 ,,
5	0·3590	1·52	control	—
6	0·3727	1·46	13 hr.	decrease
7	0·3634	1·61	24 ,,	6 per cent
8	0·3820	1·57	48 ,,	—

Reagent *A* was used for the first four samples, and reagent *B* for the others. Oxalacetic acid is considered preferable to succinic acid for this work.

Further results were obtained using samples of the same species from the same locality. Small larvæ and small amounts were used, but with slightly different reagents. Reagent *C* contained 0·1 per cent of aspartic acid and had a pH = 7·2; reagent *D* contained 0·0669 per cent of oxalacetic acid, 1 per cent dextrose and 12 per cent phosphate besides the sodium chloride; its pH = 7·7. Reagent *E* was the same as *A* except for dextrose (1·5 per cent) and 5·4 per cent K_2HPO_4, pH = 7·0. Reagent *F* contained 0·132 per cent of oxalacetic acid and the higher amounts of dextrose and phosphate, pH = 7·0.

In the following samples, reagent *C* was used for 1 and 2; reagent *D* for 3 and 4; reagent *E* for 5 and 6; and *F* for 7 and 8.

Sample	Dry weight (gm.)	Per cent N in dry material	Duration of fixation	Increase of N
1	0·0922	2·89	control	—
2	0·0923	3·19	12 hr.	10 per cent
3	0·0950	3·46	control	—
4	0·0885	3·64	12 hr.	5 ,,
5	0·1804	1·78	control	—
6	0·1798	1·84	12 hr.	3 ,,
7	0·3816	0·84	control	—
8	0·2572	1·33	12 hr.	60 ,,

A third series of tests was made with *Ips typographus* L. and *Ips* (*Pityogenes*) *chalcographus* L., from Broumov Rocks (August 1948), using an oxalacetic acid reagent.

Sample	Dry weight (gm.)	Per cent N in dry material	Duration of fixation	Increase of N
1	0·1919	1·46	control	—
2	0·1872	1·39	14 hr.	—
3	0·1819	1·12	24 ,,	—
4	0·2016	1·59	control	—
5	0·2086	1·67	14 hr.	Increase
6	0·2142	1·57	24 ,,	—
7	0·1944	1·63	48 ,,	Increase
8	0·2024	1·28	control	—
9	0·1887	1·11	14 hr.	—
10	0·1929	0·98	control	—
11	0·1863	1·09	14 hr.	Increase 11 per cent

In the first three samples, the *I. typographus* were very small; small to medium specimens were used in samples 4–7 and medium ones in 8 and 9. The last two samples were young larvæ of *I. chalcographus*. In the first three samples the adipose tissue with symbionts had probably not developed, hence no nitrogen fixation. In the other samples of *I. typographus* the larvæ were probably too old, hence only a small increase or decrease of nitrogen was observed.

In the last two, *I. chalcographus* definitely fixed free nitrogen.

Another series of samples, also collected at Broumov in August 1948, were similarly treated with the same reagent, samples 1–6 with 2 c.c. and 7–11 with 3 c.c. *I. typographus* larvæ longer than 4 mm. were used in samples 1 and 2; *I. chalcographus* (small, young larvæ up to 2 mm.) was used in samples 3–6; samples 7 and 8 were medium-sized larvæ of the same species (up to 3 mm. in length), and samples 9–11 consisted of larvæ up to 5 mm. long.

Sample	Dry weight (gm.)	Per cent N in dry material	Duration of fixation	Increase of N
1	0·1597	1·36	control	—
2	0·1604	1·44	13 hr.	about 6 per cent
3	0·1457	lost	—	—
4	0·1414	1·09	13 hr.*	—
5	0·1492	1·27	26 ,,	6 ,,
6	0·1423	1·33†	72 ,,	21 ,,
7	0·2211	1·39	control	—
8	0·2314	1·59	13 hr.	14 ,,
9	0·2348	1·43	control	—
10	0·2388	1·41	13 hr.	—
11	0·2356	1·39‡	26 ,,	—

* Control. † In contrast with 4. ‡ Larvæ too old.

Thus, on the whole, in all four series there is an increase in the nitrogen content of the larvæ, agreeing with our cytological considerations. This also coincides with the rapid breeding of these insects, though it is not so remarkable as with Aphides. It affords an explanation of the damage caused by *Ips*, and the question arises whether this behaviour can be controlled and even put to some use.

More than a hundred eggs as well as many larvæ were used in order to isolate the symbiotic organisms. In the adipose tissues it is mainly *Torulopsis* (*Cryptococcus*), an extremely variable organism, in contrast with previous experience. In addition, many strains of *Candida* were isolated as well as various species of bacteria, some resembling *Azotobacter*.

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MUSHROOM RESEARCH STATION AT YAXLEY

By Dr. R. L. EDWARDS
Director of Research

RESEARCH on some of the problems of mushroom growing has been carried on for many years, particularly in France and in the United States. Two aspects have received special attention —the chemical and microbiological changes in horse manure during composting, and the fungus diseases of mushrooms and mushroom beds. The principal British work on mushroom cultivation is that of Ware on diseases and of Pizer on horse-manure composts. Recently the mechanization of transport has caused an increasing shortage and rise in price of horse manure, and this has become a major problem. Research on synthetic composts was in progress in the United States twenty years ago, and several formulæ have been published; but many of the materials used are not available in Great Britain. Since the end of the War, American growers and research workers have devoted more attention to methods of using the available supplies of horse manure more economically, and to mechanization of their cultural operations. Synthetic composts are not widely used. Some work on synthetic composts was done in France during the 'thirties, but horse manure is still the only medium used commercially.

In 1945 a group of British mushroom growers decided to set up their own research station at Yaxley, with the development of a commercially satisfactory synthetic compost as the main problem. A laboratory, two test-houses, and a covered turning shed were built, and work started in 1946. Six experimental crops have been grown during the past three years, and the main requirements for making a productive synthetic compost from wheat straw have been established. Small-scale tests on a commercial farm have given a yield comparable with the best obtained from horse manure.

As a result of consultations between the Mushroom Research Association, Ltd., which has financed the research station until now, the Mushroom Growers' Association (a specialist branch of the National Farmers' Union) and the Ministry of Agriculture, arrangements are being made for the Research Association to receive a grant from the Ministry and to publish all its results.

Each main cropping-experiment now includes twenty-four composts of about half a ton each, made up side by side in two rows, and separated by iron sheets, so that aeration and losses of heat and moisture are similar to those occurring in one long stack of compost. In this way the replicated comparisons and factorial experiments familiar in agricultural research can be carried out. Analyses and microbiological examinations of the composts are made at suitable stages. Some of the results obtained in this way are likely to interest workers on agricultural composts.

The main nutrients studied are nitrogen, phosphorus, potassium and calcium. The source of nitrogen is very important, organic nitrogen giving higher yields than the inorganic forms so far tested. An empirical mixture of twelve trace-elements has quite a pronounced effect; one problem for the future is to determine which of these are essential and in what proportions. Preliminary experiments with growth substances suggest that further work in this field may give results of practical value, in addition to its scientific interest. The number of mushrooms produced has been increased in several experiments, and earlier fruiting has been obtained.

Variations in the depth of beds and in the intervals at which spawn is sown have quite marked effects on the time of fruiting and on yield. In the course of these experiments the number and size of mushrooms produced are recorded daily, and some measurements of their rate of growth and the relation between dimensions and weight are made. In several instances factors affecting the number of mushrooms produced have been distinguished from those affecting their size, and this work will add much to our knowledge of the appearance of mushrooms in flushes, the opening of the veil, which is subject to considerable variations, and the exhaustion of mushroom beds. These fundamental aspects of mushroom 'macrobiology' have been almost entirely ignored in the past, and their elucidation is of scientific and practical interest.

VELOCITY OF LIGHT AND MEASUREMENT OF DISTANCES BY HIGH-FREQUENCY LIGHT SIGNALLING*

By E. BERGSTRAND
Geographical Survey Office, Stockholm

FIZEAU'S principle of determination of the velocity of light can be used for the measurements of lengths. In modern form an arrangement according to this principle is shown in Fig. 1.

L is the source of light, having a spherical mirror to collect the light in a beam. The source is influenced by high-frequency tension from the crystal-controlled oscillator *Cr*, and thus the intensity of the light emitted varies with the frequency of the oscillator. *M* is a plane mirror, which reflects back the light to the phototube *Ph*. The phototube gets its operating tension from the oscillator *Cr*. Accordingly, the sensitivity of the tube varies with the same frequency as the intensity of the emitted light. As the rapid blinks of light take a certain time to cover the distance to *M* and back again, the moments of high sensitivity of the tube will be more or less timed to the incoming blinks, depending on the distance *D*. Fig. 2 shows how the recording current directed by the phototube depends on the distance *D*.

Fig. 1

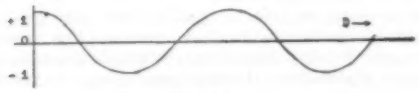

Fig. 2

A low-frequency alternating phase displacement of 180° of the high-frequency light variations makes the current exactly symmetrical with respect to the zero-line. By this means we get sharply marked positions of the mirror where the current is zero. The distance between the zero positions depends on the frequency of the oscillator *Cr*. In the actual apparatus, the frequency is 8·3 Mc./sec., corresponding to a wave-length λ of 36 metres. Thus the current becomes zero every ninth metre in accordance with the expression

$$D = K + \frac{2N - 1}{8} \cdot \lambda,$$

where *D* is the distance to be measured, *K* is a constant, depending on the apparatus used, λ is the wave-length, depending on the frequency and here being 36 metres, *N* is a whole number + 1, 2, 3, 4, ... Usually *N* is known from an approximate knowledge of *D*; if not, it may be determined by variation of λ. The values of *D* corresponding to $N = 1, 2, 3, \ldots$ are constant to the same degree as the frequency is constant, that is, to one part in ten millions; they depend also on the accuracy with which the atmospheric conditions are known. Thus the influence of temperature is 0·9 cm. per degree C. and 0·4 cm. per millibar air pressure, for a distance *D* of 10 kilometres.

In the field, the mirror *M* usually is not placed exactly at a zero-point. We then decrease the frequency slightly from its 'normal' value. The farthest zero-point glides out and passes the mirror. Just then the photo-current changes its direction and passes through zero. We now read off the change of frequency and get the distance of the mirror from the farthest 'normal' zero-point. In this way we get the extreme value of the distance to be determined. The other end is fixed in a similar way. Here we use the value of *D* for $N = 1$. This distance, about 1 metre, is very constant. By means of a variable loop of light, it can be determined or controlled. To get the main constant of the apparatus, the first determination is made on a known base-line.

At a value of *D* of 9 km., the sensibility of adjustment commonly was 0·4 cm. as a mean error of six determinations during a quarter of an hour. Measurements on different days showed a maximum divergence of 3 cm.

Knowing the frequency, we determined the velocity of light *in vacuo* to be 299·796 ± 2 km. per sec. We intend to make further measurements in March; therefore, the values given above should not be considered as definite.

A.G.A., Stockholm, intend to manufacture the 'geodimeter' for sale.

REFERENCES
Bergstrand, *K. Vetenskapsakad. Arkiv, M.A.F.*, Nr. 30 (Stockholm, 1943); Nr. 20 (Stockholm, 1949); *Acta Com. Geod. Baltica* (Helsinki, 1948).

* From a paper presented at the International Union of Geodesy and Geophysics, Oslo, 1948.

PHOTOMETRY OF THE CONTINUOUS SPECTRUM

PROF. W. M. H. GREAVES, president of the Royal Astronomical Society, delivered his presidential address on February 14, 1948, to the Society at Burlington House, selecting as his topic "The Photometry of the Continuous Spectrum". As Prof. Greaves pointed out at the beginning of his address, he was encouraged to make the attempt of presenting a survey of the subject by the consideration that it "can be used to illustrate the way in which Natural Knowledge is advanced by an interplay between observational and theoretical investigations". The address involves so many technical matters and is so comprehensive that no attempt can be made in this short notice to deal with it in detail; and those who are specially interested in the subject should study the paper itself (*Mon. Not. Roy. Astro. Soc.*, **108**, No. 1; 1948).

A general description is given of the kind of measurement which is undertaken in this comparatively new technique and also of the relation of this technique to that of classical photometry; after this there is a review of the theoretical work on spectral energy distribution which has taken place during the last two decades. The theory of the radiative equilibrium of stellar atmospheres had been independently developed by Lindblad and Milne, and, on the assumption that the stellar absorption coefficient did not vary with wave-length, Milne

showed that the stars would radiate like black bodies. The calculated values for the sun's centre-limb contrast, which agreed well with the available data, seemed to substantiate this view, and the theory gave a definite set of temperatures—those of the Fowler–Milne scale—which were approximately identified with colour temperatures. The well-known work of Greaves, Davidson and Martin at Greenwich on the gradient difference between stars of spectral types *B*0 to *B*3 and stars of spectral type *A*0 showed a colour-temperature of 18,000° for *A*0-stars at a wave-length of 5000 A. as against the Fowler–Milne value of 10,000°; and it was necessary to discard Milne's provisional assumption that the stellar absorption coefficient did not vary with wave-length.

Reference is made to the advances which attended the work of McCrea, who calculated the emergent radiation for a model star composed entirely of atomic hydrogen, and of Pannekoek, who independently repeated McCrea's investigations, taking into account the contribution of metallic atoms in the stellar atmospheres. Also dealt with is the observational progress which was made during 1934–39 through the work of Barbier, Chalonge and their collaborators at Jungfraujoch, of Kienle and his colleagues at Göttingen, and R. C. Williams at Ann Arbor. Many others matters are included in the address, and towards the end Prof. Greaves expressed his personal opinion that, though the existence of intrinsic reddening in addition to space reddening has not been absolutely established, the balance of evidence favours the view that reddening by interstellar scattering is not the only process involved. Before attempting the task of interpretation, further measures are very desirable, and in particular the study of the variation of gradient excess with wave-length from the near infra-red to the near ultra-violet.

RUBBER RESEARCH INSTITUTE OF THE DUTCH EAST INDIES

THE Rubber Research Institute of the Dutch East Indies at Buitenzorg, Java, has recommenced publication after the delay of several years caused by the Japanese occupation, and a number of its recent reports contain points of interest.

Publication No. 38 shows that rubber obtained immediately after tapping the tree is readily soluble in petroleum ether, but on standing in the light it gradually becomes insoluble, especially if stored in the form of latex. These changes naturally complicate the supposed distinction between 'sol' and 'gel' rubber.

Publication No. 39 emphasizes the important bearing which the method of preparation of rubber has upon the physical properties of the final vulcanized article, especially in respect of water absorption and tension strength in the wet state; for example, whole-latex rubbers are much stronger when dry than when wet.

A study of the nature of the naturally occurring antioxidants in rubber latex (Publication No. 54) has shown that the amino-acids have a remarkably powerful antioxidant action. The spontaneous coagulation of *Hevea* latex has frequently been believed to result from progressive lowering of *p*H, but it still occurs even when the *p*H is kept constant, and work done in Java (Publication No. 58) suggests that the removal of magnesium ions, as a fatty soap, is the main cause of coagulation.

The vexed problem of the value of incorporating rubber powder in roadways receives a contribution in Publication No. 61, where it is shown that the durability of bituminous coatings in Java is much improved by the addition of rubber powder.

Some of those who use raw rubber have for long maintained that the 'fine hard Para', produced under primitive conditions in Brazil, is of superior quality to that produced on plantations. This controversy will presumably be revived by the report, given in Publication No. 62, that smoked sheets produced under primitive conditions in West Borneo may be of superior quality to those produced by native labour, following modern practice, in south Borneo.

The marked differences between fresh latex and old latex, some of which were commented on above, are responsible for an interesting development which is fully described in Publication No. 68. When old vulcanized latex is coagulated, a continuous coagulum is obtained; but if fresh latex is used for the vulcanizing process, and the product is then coagulated, the coagulum is not coherent and forms a powder, known as 'Mealorub', on drying. This very economical method of producing a powdered rubber will be watched with considerable interest, especially from the point of view of its use as a means of preventing the flow of road bitumens in hot weather, and as a means of binding certain types of road aggregates.

R. G. NEWTON

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, February 28

UNIVERSITY OF LONDON (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 4.45 p.m.—Prof. C. Rimington: "Haem Pigments in Nature".* (Further Lecture on March 7.)

INSTITUTION OF THE RUBBER INDUSTRY, MANCHESTER AND DISTRICT SECTION (at the Engineers' Club, Albert Square, Manchester), at 6.15 p.m.—Dr. L. R. G. Treloar: "Rubber Physics applied to Engineering Problems".

CHEMICAL SOCIETY, EIRE SECTION (joint meeting with the UNIVERSITY COLLEGE OF DUBLIN CHEMICAL SOCIETY and the WERNER SOCIETY, in the Department of Chemistry, University College, Dublin), at 7.45 p.m.—Prof. T. Dillon: "Researches on the Chemistry of the Algæ".

CHEMICAL SOCIETY, OXFORD SECTION (joint meeting with the ROYAL INSTITUTE OF CHEMISTRY, in the Physical Chemistry Laboratory, Oxford), at 8.15 p.m.—Mr. C. S. Robinson: "Research and Productivity in Industry" (Alembic Club Lecture).

Tuesday, March 1

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Mr. R. B. Freeman: "The Life of Fleas".*

MANCHESTER GEOGRAPHICAL SOCIETY (at the Geographical Hall, St. Mary's Parsonage, Manchester), at 6.30 p.m.—Mr. T. Yeldham Unwin: "A Tale of Two Cities and other Places".

Wednesday, March 2

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. E. C. Cherry: "The Analogies between the Vibrations of Elastic Membranes and the Electro-magnetic Fields in Guides and Cavities".

UNIVERSITY OF LONDON (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. Tore Levring (Göteborg): "Submarine Daylight, Photosynthesis and Vertical Distribution of Marine Algæ".* (Further Lecture on Friday, March 4.)

MANCHESTER METALLURGICAL SOCIETY (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. C. G. Conway: "Metallurgical Problems involved in the Manufacture of Components for Jet Engines".

Thursday, March 3

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

CHEMICAL SOCIETY, NORTH WALES SECTION (in the Edward Davies Chemical Laboratories, Aberystwyth), at 5 p.m.—Dr. E. A. Moelwyn-Hughes: "The Liquid State".

ROYAL METEOROLOGICAL SOCIETY (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 6 p.m.—Prof. Gordon Manley: "British Climatic Fluctuations since Queen Elizabeth's Day".

INSTITUTION OF CIVIL ENGINEERS, NORTH-WESTERN SECTION (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. H. J. B. Harding: "Site Investigations, including Boring and other Methods of Surface Exploration".

BRITISH INSTITUTION OF RADIO ENGINEERS, NORTH-WESTERN SECTION (in the Reynolds Hall, College of Technology, Manchester), at 6.45 p.m.—Mr. M. A. Alexander: "Some Radar Applications".

LEEDS METALLURGICAL SOCIETY (in the Chemistry Department, The University, Leeds), at 7 p.m.—Mr. E. W. Colbeck: "Metallurgical Problems in the Field of Atomic Energy".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.15 p.m.—Scientific Papers.

Friday, March 4

TEXTILE INSTITUTE (at 16 St. Mary's Parsonage, Manchester), at 1 p.m.—Mr. T. C. Williams: "Research in the Bleaching Industry".

GEOLOGISTS' ASSOCIATION (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Mr. E. Ernest S. Brown: "Work for Amateur Geologists" (Presidential Address).

INSTITUTION OF MECHANICAL ENGINEERS (joint meeting with the INSTITUTION OF ELECTRICAL ENGINEERS, at Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—Mr. W. F. Harlow: "Causes of Flue-gas Deposits and Corrosion in Modern Boiler Plants".

ROYAL STATISTICAL SOCIETY, LONDON GROUP OF THE INDUSTRIAL APPLICATIONS SECTION (joint meeting with the LONDON SECTION of the SOCIETY OF CHEMICAL INDUSTRY, at the E.I.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Mr. G. P. Box: "Statistical Methods in the Interpretation of Experimental Results".

UNIVERSITY OF LONDON (at the Royal Holloway College, Englefield Green, Surrey), at 8 p.m.—Prof. Paul Dienes: "Science and Ethics".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. E. K. Rideal, F.R.S.: "The Foundation of the Royal Institution".

Saturday, March 5

NUTRITION SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 10.30 a.m.—Conference on "Nutrition and Fertility".

ROYAL AERONAUTICAL SOCIETY (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 11 a.m.—Discussion on "Air Safety".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ANIMAL HUSBANDRY ADVISER at the British Middle East Office in Cairo—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting G.27/49 (March 5).

DEMONSTRATORS at the Military College of Science, Shrivenham, near Swindon, in Mathematics (Ref. A.299/48A), Ballistics (Ref. A.299/48A), Physics (Ref. A.299/48A), Chemistry (Ref. F.706/48A), and Metallurgy (Ref. F.707/48A)—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (March 5).

STATISTICIAN to maintain statistical sub-offices at Entebbe and Dar-es-Salaam and to carry out surveys on behalf of the East African High Commission—The Director of Recruitment, Colonial Service, Sanctuary Buildings, Great Smith Street, London, S.W.1 (March 5).

SENIOR SCIENTIFIC OFFICERS or SCIENTIFIC OFFICERS, EXPERIMENTAL OFFICERS or ASSISTANT EXPERIMENTAL OFFICERS, for work on safety measures and other research problems connected with the industrial use of explosives and high pressure acetylene, in a Ministry of Supply Research and Development Establishment in London—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.1189/48A (March 10).

SENIOR SCIENTIFIC OFFICERS, SCIENTIFIC OFFICERS, EXPERIMENTAL OFFICERS and ASSISTANT EXPERIMENTAL OFFICERS (unestablished) with practical experience of the working and deformation of metals or of experimental technique in determining alloy constitution, or some knowledge of powder metallurgy, metallography, physics of metals, X-ray crystal analysis or corrosion problems, in Ministry of Supply Research and Development Establishments in London and South England—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.1190/48 (March 10).

PRINCIPAL SCIENTIFIC OFFICERS or SENIOR SCIENTIFIC OFFICERS, with recognized qualifications in veterinary science with research experience in bacteriology, for unestablished veterinary research posts in a Ministry of Supply Research and Development Establishment in Wilts—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting G.8/49A (March 10).

SCIENTIFIC OFFICERS with good Honours degree in a biological science or in chemistry, with research experience in biochemistry, physiology, pathology, pharmacology, or bacterial chemistry, and EXPERIMENTAL OFFICERS with a minimum of three years laboratory experience in pathology, bacteriology, biochemistry or physiology, at Ministry of Supply Research and Development Establishments in Wiltshire and Hampshire—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting G.550/48 (March 10).

CHEMIST or CHEMICAL ENGINEER for fundamental theoretical and experimental work including work on corrosion, a CHEMICAL ENGINEER for development of chemical processes subsequent to the laboratory stage and design of plant from pilot plant to larger scale, a PHYSICIST for design, development, manufacture and operation of special instruments for chemical plant, and a MECHANICAL ENGINEER for experimental work on problems of stress measurement and high pressure technique, etc., in the Chemical Engineering section of a Ministry of Supply Research and Development Establishment in Essex—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.1188/48A (March 10).

EXPERIMENTAL EMBRYOLOGIST or IMMUNOLOGIST in the Department of Zoology—The Secretary and Registrar, University College of North Wales, Bangor (March 11).

PHYSICIST in charge of a section concerned with the application of radio-active tracer elements—The Registrar, The University, Reading (March 12).

SENIOR SCIENTIFIC OFFICERS (with good honours degree in chemistry or physics or equivalent qualification) and SCIENTIFIC OFFICERS (with good honours degree in chemistry or equivalent qualification), for analytical work in connexion with atomic energy development (Ministry of Supply Chemical Inspectorate)—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.48/49A (March 12).

LECTURERS IN THE DEPARTMENT OF ELECTRICAL ENGINEERING (Electrotechnics)—The Registrar, The University, Liverpool (March 14).

READERSHIP IN THEORETICAL PHYSICS at Queen Mary College—The Academic Registrar, University of London, Senate House, London, W.C.1 (March 21).

PROFESSOR OF ORGANIC CHEMISTRY, and a PROFESSOR OF THEORETICAL PHYSICS, in the University of Cape Town—The Secretary, Association of Universities of the British Commonwealth, 32 Woburn Square, London, W.C.1 (March 31).

CHAIR OF PHYSIOLOGY at King's College, Newcastle-upon-Tyne—The Registrar, University Office, 46 North Bailey, Durham (March 31).

I.C.I. RESEARCH FELLOWSHIPS in Chemistry or Physics, or some allied subject such as Biochemistry, Chemotherapy, Pharmacology, Metallurgy or Engineering—The Registrar, The University, Liverpool (April 15).

RAMSAY MEMORIAL FELLOWSHIPS FOR CHEMICAL RESEARCH—The Joint Honorary Secretaries, Ramsay Memorial Fellowships Trust, University College, Gower Street, London, W.C.1 (April 16).

GEOLOGISTS in the Colonial Geological Survey Service (mainly in the East and West African Dependencies, the Federation of Malaya, and the British Solomon Islands Protectorate)—The Director of Recruitment, Colonial Service, Sanctuary Buildings, Great Smith Street, London, S.W.1.

INDUSTRIAL CHEMIST at a Ministry of Supply factory in Nottinghamshire, to be responsible under the Chemist-in-charge for the chemical, metallurgical and testing laboratories and the electro-deposition plant at a heavy engineering factory—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.65/49A.

GRADUATE or A.R.I.C. for analytical research for metallurgical problems—The Director, British Cast Iron Research Association, Alvechurch, Birmingham.

GRADUATE (or equivalent) as Assistant in enquiry laboratory dealing with works problems submitted by member firms—The Printing, Packaging and Allied Trades Research Association, Randall Road, Leatherhead, Surrey.

PHYSICAL CHEMIST (Assistant Scientific Officer or Scientific Officer grade) with an Honours degree in Chemistry, to carry out research on rubber latex and other emulsion systems—The Secretary, Research Association of British Rubber Manufacturers, 105-7 Lansdowne Road, Croydon, Surrey.

BACTERIOLOGIST (male) for work in the Stack Laboratories, Khartoum—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Bacteriologist'.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Medical Research Council. Memorandum No. 19: The Rh Blood Groups and their Clinical Effects. By Dr. P. L. Mollison, Dr. A. E. Mourant and Dr. R. R. Race. Pp. 74. (London: H.M. Stationery Office, 1948.) *1s. 6d.* net. [149

Field Crop Abstracts. Vol. 1, No. 1, January 1948, Abstracts 1 to 446. (Aberystwyth: Commonwealth Bureau of Pastures and Field Crops, 1948.) Annual subscription, *35s.* [189

Society of Public Analysts and other Analytical Chemists: Physical Methods Group and Biological Methods Group. Symposium on Methods of Penicillin Assay: their Purpose, Scope and Validity. Pp. iv+34. (Cambridge: W. Heffer and Sons, Ltd., 1948.) *3s. 6d.* net. [209

Other Countries

Annual Report of the Coconut Research Scheme for 1946. Pp. 22. (Colombo: Government Publications Bureau, 1948.) 45 cents. [149

United States Department of Commerce: National Bureau of Standards. Circular No. 462: Ionospheric Radio Propagation. Pp. iv+209. (Washington, D.C.: Government Printing Office, 1948.) 1 dollar. [149

Teknik Dergi (Turkish Technical Review). Yil 1, Sayi 1, Agustos 1948. Pp. 48. (Istanbul: Teknik Dergi, 1948.) 1 T.L., 1 dollar; annual subscription, 12 T.L., 10 dollars. [189

Sugar Research Foundation. Scientific Report Series, No. 10: Chromatography of Sugars and related Substances. By Dr. Wendell W. Binkley and Prof. Melville L. Wolfrom. Pp. v+34. (New York: Sugar Research Foundation, Inc., 1948.) Free. [189